923

1900A
Multifunction Counter

Instruction Manual

FLUKE®

1900A
Multifunction Counter

Instruction Manual

P/N 384875
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FLUKE®

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WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

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2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

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All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way"* prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

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*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

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Section 1

Introduction & Specifications

1-1. INTRODUCTION

1-2. The Fluke Model 1900A is a 5 Hz to 80 MHz multiple-function counter capable of making frequency, period, period averaging and totalize measurements. In the frequency mode, resolution is manually selectable at 0.1 Hz, 1.0 Hz, 10 Hz and 100 Hz. In the period averaging mode, the number of periods averaged is manually-selectable at 10^0, 10^1, 10^2 and 10^3 periods. Automatic selection of resolution and number of periods averaged (autoranging) is also provided to automatically select the optimum range for a particular input signal. However, the 100 Hz resolution and 10^3 periods must be manually selected.

1-3. The measurement display is six digits, light-emitting-diode-type (LED) with leading-zero suppression and automatic decimal point positioning. Annunciators are provided to indicate measurement units (kHz, MHz, milliseconds and microseconds) and also overflow when the capacity of the display is exceeded. All displayed information is also available, in parallel BCD format, at a rear-panel connector when the unit is equipped with an optional Data Output Unit (DOU).

1-4. The Model 1900A is equipped with a selectable 1 MHz low-pass filter for use in electrically noisy environments, and a selectable 10:1 attenuator for use with high-level inputs. A self-check mode of operation is provided to verify overall performance of the unit. Power requirements are 100, 115 or 230 volts at 50 to 400 Hz for the line-powered version. An optional battery-powered version, Model 1900A–01, provides for use away from ac power lines and is equipped with rechargeable nickel-cadmium batteries. The battery-powered version also operates from the ac lines, but only at the power line frequency and voltage specified on the bottom of the instrument.

1-5. SPECIFICATIONS

1-6. The pertinent specifications for the Model 1900A are listed in the following Table 1-1.

Table 1-1. MODEL 1900A SPECIFICATIONS

OPERATING RANGES

Frequency:
5 Hz to 80 MHz

Period:
5 Hz to 1 MHz single and multiple period averages

Totalize:
1 count to 999999 counts

INPUT CHARACTERISTICS

Sensitivity:
25 mV, typically 15 mV rms sine wave, 5 Hz to 80 MHz
Frequency and totalize: 200 mV P-P pulse amplitude with minimum pulse width of 20 nsec. Duty cycle > 10%.
Period: 200 mV P-P pulse amplitude with minimum pulse width of 200 nsec. Duty cycle > 10%.

Impedance:
1 MΩ shunted by less than 30 pf for signal levels < 500 mV decreasing to approx. 220K shunted by less than 40 pf for levels greater than 500 mV.

Filter:
1 MHz (3dB point) lowpass

Attenuator:
Decreases sensitivity by 10

Overload:
250V rms 5 Hz to 1 kHz decreasing to 20V at 80 MHz

RESOLUTION

Frequency:
Four manually selected gate times of:
10ms (100 Hz resolution)
100ms (10 Hz resolution)
1s (1 Hz resolution)
10s (0.1 Hz resolution)

Autorange position will automatically seek to fill all 6 digits but will not select a gate time greater than 1 second (1 Hz resolution)

Period:
Manual selection of single period through 10^3 periods averaged ratios:
10^0 single period (100 ns resolution)
10^1 periods averaged (10 ns resolution)
10^2 periods averaged (1 ns resolution)
10^3 periods averaged (100 ps resolution)

Autorange position will automatically seek to fill all 6 digits. Autoranging will not select a period average of greater than 10^2 averages.

Totalizing:

Accumulates up to 999999 counts, then activates overflow indicator.

TIME BASE CHARACTERISTICS

Frequency: 10 MHz

Stability:
Aging Rate: $< \pm 5 \times 10^{-7}$ month
Short Term: $< \pm 5 \times 10^{-8}$ over 1 second
Temperature: $< \pm 5 \times 10^{-6}$ 0°C to 50°C
$< \pm 2 \times 10^{-6}$ (typical) 20°C to 30°C

Line Variation:
$< \pm 1 \times 10^{-7}$ for ±10% variation in line voltage

GENERAL

Display:
6 digit LED, leading zero suppression
Time between successive measurements is 200 ms plus measurement time

Annunciation:
MHz, kHz, msec, μs overflow

Automatic Features:
AUTORANGE:
In both frequency and period modes, autoranging includes a unique 20% hysteresis in its switching thresholds, to eliminate redundant up range/down range commands. This allows measurements to be made on signals containing large amounts of FM and PM.
Hysteresis memory can be reset by depressing the reset button.
AUTORESET:
A new measurement sequence is started every time a front panel button is activated.

Operating Temp: 0°C to +50°C (0°C to +40°C for -01 Battery option if operated from line.

Storage Temp: –40°C to +60°C

Power Requirements:
115/230 VAC ±10% - 100 VAC available - 50, 60, 400 Hz - 6.5 watts line model - 8.5 watts battery model

Fuses:
1/4A AC-line version-½ A slo-blo battery version

DIMENSIONS

Width:	8.55 inches	217.2 mm
Height:	2.52 inches	64.0 mm
Depth:	10.65 inches	270.5 mm
Weight:	2.75 lbs	1.2 Kg

DATA OUTPUT OPTION

8-4-2-1 BCD output from each digit, plus encoded decimal point and units annunciation information. All outputs CMOS/Low Power TTL compatible, high true. Print command is provided.

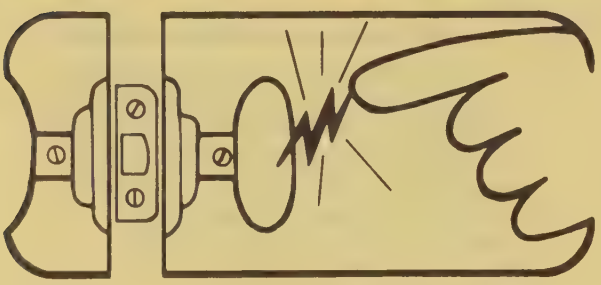
BATTERY

NICAD rechargeable - discharge time 5 hours - charge time 14 hours @ ≤ 30°C ambient with unit inoperative.

static awareness

A Message From

John Fluke Mfg. Co., Inc.

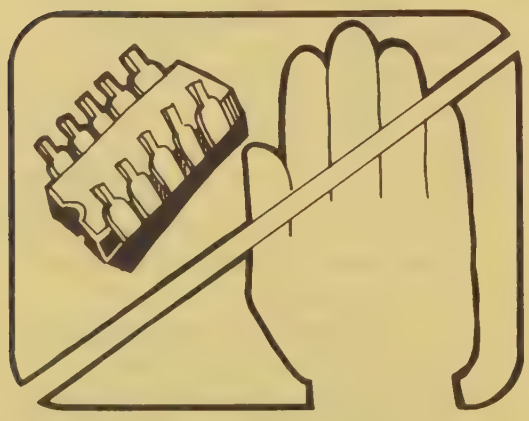


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

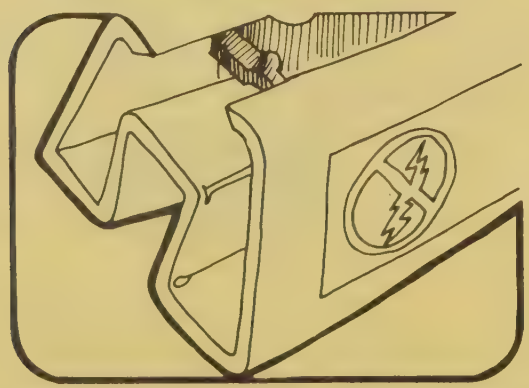
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗"

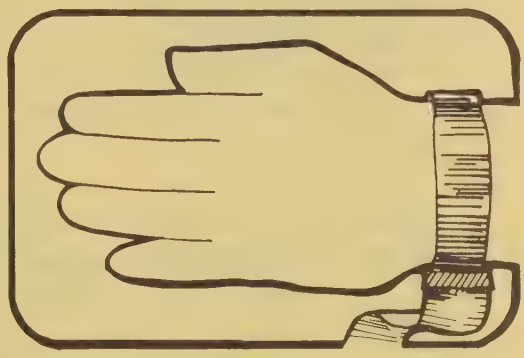
The following practices should be followed to minimize damage to S.S. devices.



1. MINIMIZE HANDLING

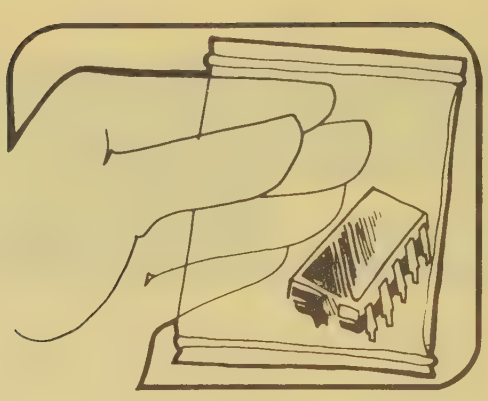


2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.

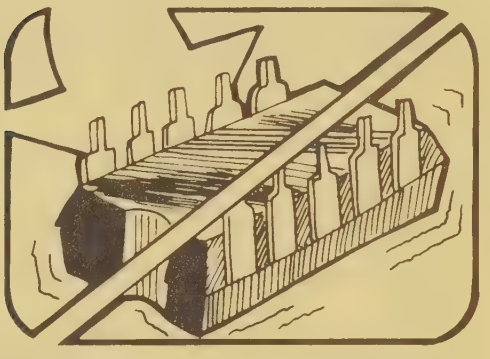


3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.

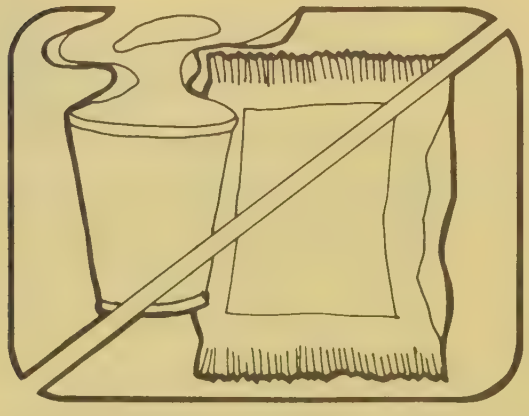
4. HANDLE S.S. DEVICES BY THE BODY



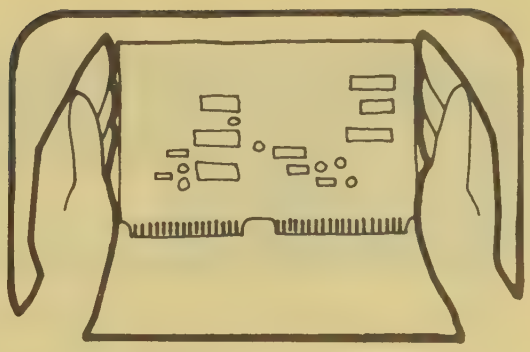
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT



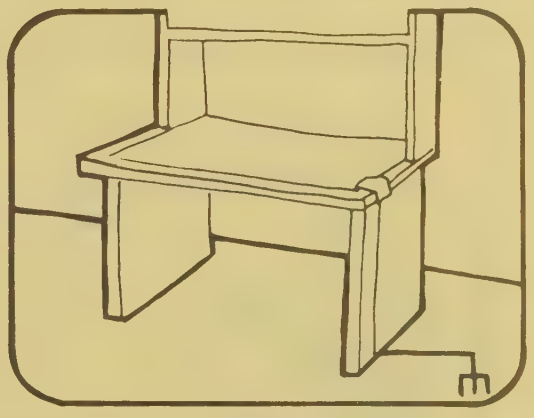
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS TO PROTECT INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION
10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.
11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

A complete line of static shielding bags and accessories is available from Fluke Parts Department, Telephone 800-526-4731 or write to:

JOHN FLUKE MFG. CO., INC.
PARTS DEPT. M/S 86
9028 EVERGREEN WAY
EVERETT, WA 98204

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Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section contains operating information for the Model 1900A. The contents of this section should be read before operating the counter. Should any difficulties arise during operation of this instrument, please contact your nearest John Fluke Sales Representative, or the John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043; telephone (206) 774-2211. A list of Sales Representatives is located at the rear of this manual.

2-3. SHIPPING INFORMATION

2-4. The Model 1900A is packaged and shipped in a protective container. Upon receipt of the equipment, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included in the shipping carton.

2-5. If reshipment of the equipment is necessary, the original container should be used. If the original container is not available, a new container can be obtained from the John Fluke Mfg. Co. Please reference the equipment model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. The Models 1900A and 1900A–01 are supplied with one of three ac input power configurations. These consist of 100Vac, 115Vac and 230Vac; at 50 to 400 Hz. Before connecting to the ac line power, insure that the instrument is in the proper configuration for your power lines. A decal on the underside of the instrument indicates the ac line voltage and frequency required.

CAUTION

The battery-powered version must be operated at the line frequency stamped on the bottom–panel decal.

2-8. RACK INSTALLATION

2-9. The Model 1900A may be mounted in a standard 19-inch rack when supplied with the appropriate rack mounting kit. Rack mounting kits are available to allow left, right or center mounting. Instructions for installing units in the rack mount are supplied with the rack mounting kit. The center rack mounting kit is Model No. M00-200-612. The offset rack mounting kit is Model No. M00-200-611.

2-10. OPERATING FEATURES

2-11. The location and function of all controls, connectors, and indicators are shown in Figure 2-1. Operating features and instructions for accessories are discussed in Section 6.

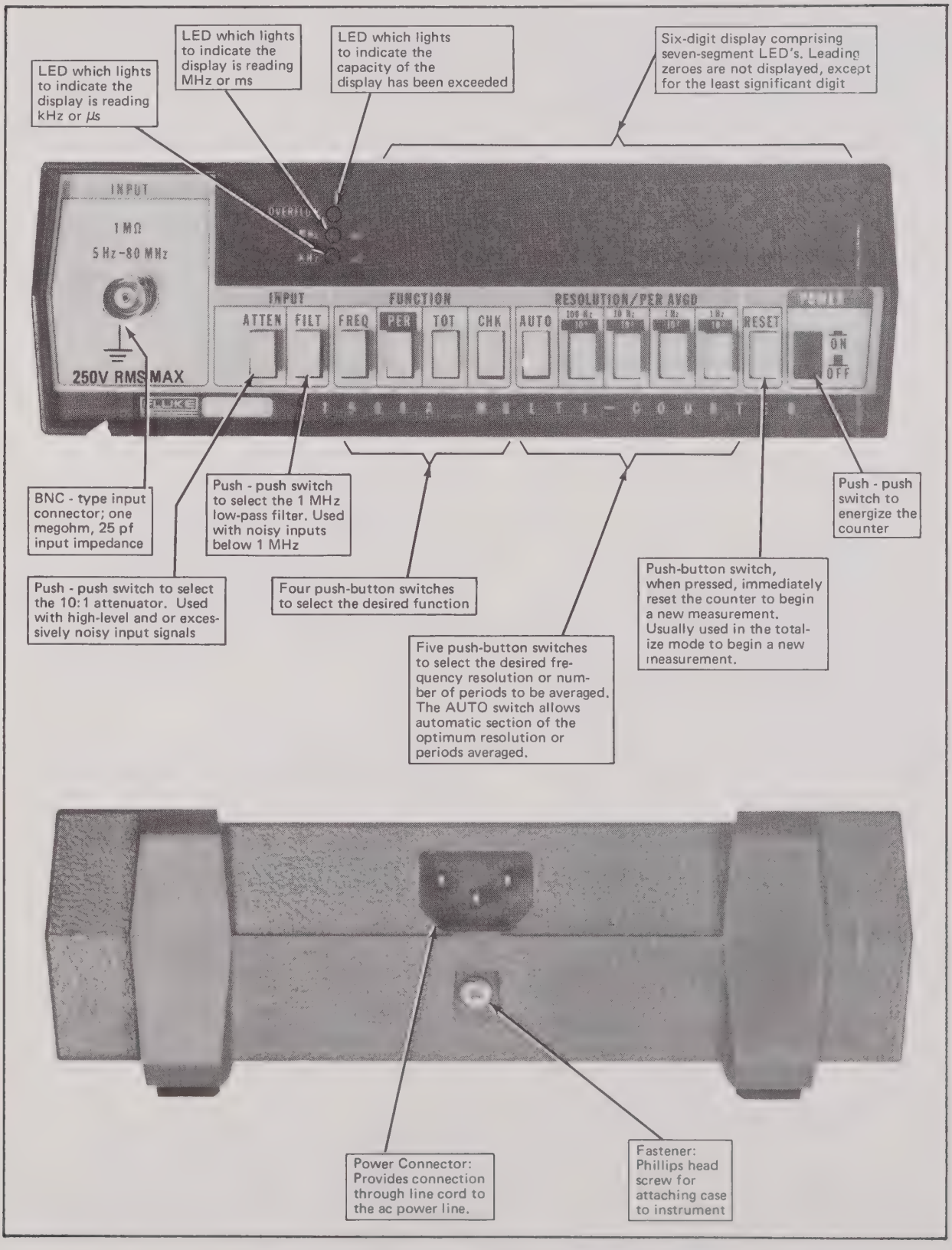
LED which lights to indicate the display is reading kHz or μs
LED which lights to indicate the display is reading MHz or ms
LED which lights to indicate the capacity of the display has been exceeded
Six-digit display comprising seven-segment LED's. Leading zeroes are not displayed, except for the least significant digit
INPUT
1 MΩ
5 Hz-80 MHz
250V RMS MAX
OVERFLOW
INPUT
FUNCTION
RESOLUTION/PER AVGD
ATTEN
FILT
FREQ
PER
TOT
CHK
AUTO
RESET
ON
OFF
BNC - type input connector; one megohm, 25 pf input impedance
Push - push switch to select the 10:1 attenuator. Used with high-level and or excessively noisy input signals
Push - push switch to select the 1 MHz low-pass filter. Used with noisy inputs below 1 MHz
Four push-button switches to select the desired function
Five push-button switches to select the desired frequency resolution or number of periods to be averaged. The AUTO switch allows automatic section of the optimum resolution or periods averaged.
Push-button switch, when pressed, immediately reset the counter to begin a new measurement. Usually used in the totalize mode to begin a new measurement.
Push - push switch to energize the counter
Power Connector: Provides connection through line cord to the ac power line.
Fastener: Phillips head screw for attaching case to instrument

Figure 2-1. CONTROLS, CONNECTORS AND INDICATORS

2-12. OPERATING NOTES

2-13. Input Connection

2-14. Signals to be measured by the Model 1900A are applied to the front-panel BNC connector. Connection of all input signals should be by means of coaxial-type cable fitted with a mating BNC connector. Input impedance is one megohm shunted by < 30 pf. Input sensitivity is 25 millivolts rms. The input impedance derates to approximately 220K shunted by less than 40 pf for input levels greater than 500 mV.

WARNING

The outside contact of the BNC connector is tied directly to earth ground through the power plug. DO NOT connect the active lead of input signals to the outside contact. Irrepairable damage to the 1900A may result. To measure power line frequencies, use an isolation transformer.

2-15. Overload Protection

2-16. The Model 1900A will accept inputs as high as 250 volts rms at frequencies below 1 kHz without damage. Overload capability decreases linearly from 250 volts rms at 1 kHz to 20 volts rms at 80 MHz input, as illustrated in Figure 2-2.

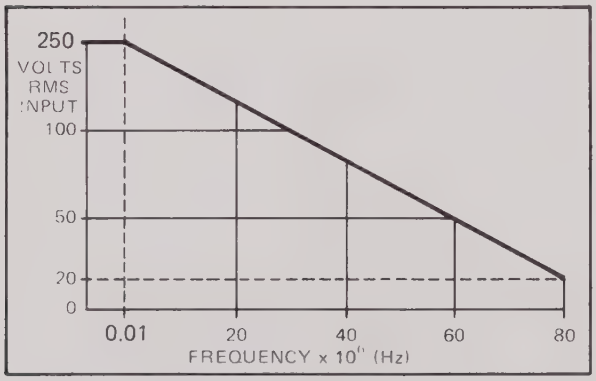

Figure 2-2. INPUT OVERLOAD PROTECTION LEVELS

2-17. FREQUENCY MEASUREMENTS

2-18. Perform frequency measurements as follows:

a. Press the POWER switch to the ON position.

b. Press the FREQ switch to select the frequency mode of operation.

c. Select the desired resolution, or the autorange mode by pressing the AUTO switch. If the input signal is completely unknown, the autorange mode will select the optimum range.

NOTE

In the autorange mode, automatic selection is made between the lower three resolutions. The 0.1 Hz resolution can only be manually selected (by means of the .1 Hz RESOLUTION switch).

d. Connect the input signal to the front-panel BNC connector. In the case of input waveform jitter or noise, spiked waveforms, or ripple on TTL waveforms, the reading obtained may be incorrect or unsteady due to false triggering of the schmitt trigger in the input section. If the signal level is greater than 150mV, depressing the ATTEN switch will decrease the triggering sensitivity of the input section by a factor of ten and reduce errors.

e. If the input signal is below 1 MHz, high-frequency noise can be eliminated by pressing the FILT switch.

f. Read the frequency on the display, and observe the unit of measurement indication (kHz or MHz) to the left of the display.

2-19. PERIOD MEASUREMENTS

2-20. Perform period measurements as follows:

a. Press the POWER switch to the ON position.

b. Press the PER switch to select the period mode of operation

c. Select the desired number of periods to be averaged, or the autorange mode by pressing the AUTO switch. If the input signal is completely unknown, the autorange mode will select the optimum number of periods to average.

NOTE

In the autorange mode, automatic selection is made between 10^0, 10^1 and 10^2 periods to be averaged. The 10^3 (1000) periods averaged can only be manually selected (by means of the 10^3 PER AVGD switch).

d. Connect the input signal to the front-panel BNC connector. In the case of input waveform jitter or noise, spiked waveforms, or ripple on TTL waveforms, the reading obtained may be incorrect or unsteady due to false triggering of the schmitt trigger in the input section. If the signal level is greater than 150mV, depressing the ATTEN switch will decrease the triggering sensitivity of the input section by a factor of ten and reduce errors.

e. If the input signal is below 1 MHz, high-frequency noise can be eliminated by pressing the FILT switch.

f. Read the period time on the display, and observe the unit of measurement indication (ms or μs) to the left of the display.

2-21. TOTALIZE MEASUREMENTS

2-22. Perform totalize measurements as follows:

a. Press the POWER switch to the ON position.

b. Press the TOT switch to select the totalize mode of operation, and the RESET switch to initialize the counter.

c. Connect the input signal to the front-panel BNC connector. In the case of input waveform jitter or noise, spiked waveforms, or ripple on TTL waveforms, the reading obtained may be incorrect or unsteady due to false triggering of the schmitt trigger in the input section. If the signal level is greater than 150mV, depressing the ATTEN switch will decrease the triggering sensitivity of the input section by a factor of ten and reduce errors.

d. If the input signal is below 1 MHz, high-frequency noise can be eliminated by pressing the FILT switch.

e. Read the accumulated total on the display.

2-23. SELF-CHECK MODE

2-24. The self-check mode provides a means of verifying proper overall operation of counter, excluding input section, time base accuracy, and time base dividers used in the period mode.

a. Press the POWER switch to the ON position.

b. Press the CHK switch to select the self-check mode.

c. Press the 100 Hz RESOLUTION switch; the display should read 1.0000 MHz, with the leading zero blanked (X1.0000).

d. Press the 10 Hz RESOLUTION switch; the display should read 1000.00 kHz.

e. Press the 1 Hz RESOLUTION switch; the display should read 00.0000 kHz, and light the OVFL annunciator.

f. Press the AUTO switch; the display should read 1000.00 kHz, as in step c.

Section 3
Theory of Operation

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. This section of the manual is divided into two parts. Overall Functional Description gives an overview of the circuit functions and how they are used in each mode. Circuit Description details the operation of each circuitry section. Simplified block diagrams are referred to by figure number. Complete schematic diagrams are located in section 8. Table 3-1 is a list of definitions for the mnemonics used in the schematic diagrams and text.

Table 3-1. MNEMONIC DEFINITIONS

BCD	Binary Coded Decimal
BL	Blank or Blanking
CLK	Clock
DP	Decimal Point
DS	Decimal Signal
FF	Flip-Flop
ICR	Iteration Counter Reset
KL	Annunciator Signal (MHz - mSec)
LSD	Least Significant Digit
ML	Annunciator Signal MHz - mSec)
MSD	Most Significant Digit
MSDM	MSD Memory
MUP	Memory Update
OV, OVFL	Overflow
RMAX	Reset to Maximum Count
RNG	Range
TOT	Total or Totalize

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. Introduction

3-5. Seven basic sections compose the circuitry of the 1900A multicounter: an input section, main gate, decade counters/display memory/ display multiplexer, display, time base, range control logic, and program control logic. The input section conditions the signal with regard to amplitude and waveshape. The main gate controls the application of the signal to be counted to the decade counters. A signal is counted by the decade counters, stored in the display memory, and multiplexed to the display on a common data bus.

3-6. The time base section provides two frequencies which compose the time base against which other signals are compared. Range control divides the time base (or the input signal in the period mode) to control the main gate. Decimal information is derived from range control. Program control consists of a sequencer and autorange logic. Understanding the sequencer logic, which controls the timing of events, is very important to understanding the functioning of the instrument. An outline of the sequence of events is given in the explanation of the frequency mode.

3-7. Frequency Mode

3-8. In the frequency mode the signal from the input section is applied to the first decade counter. Refer to figure 3-1. The duration of the count is derived from the time base. The sequence of events, as ordered by the pro-

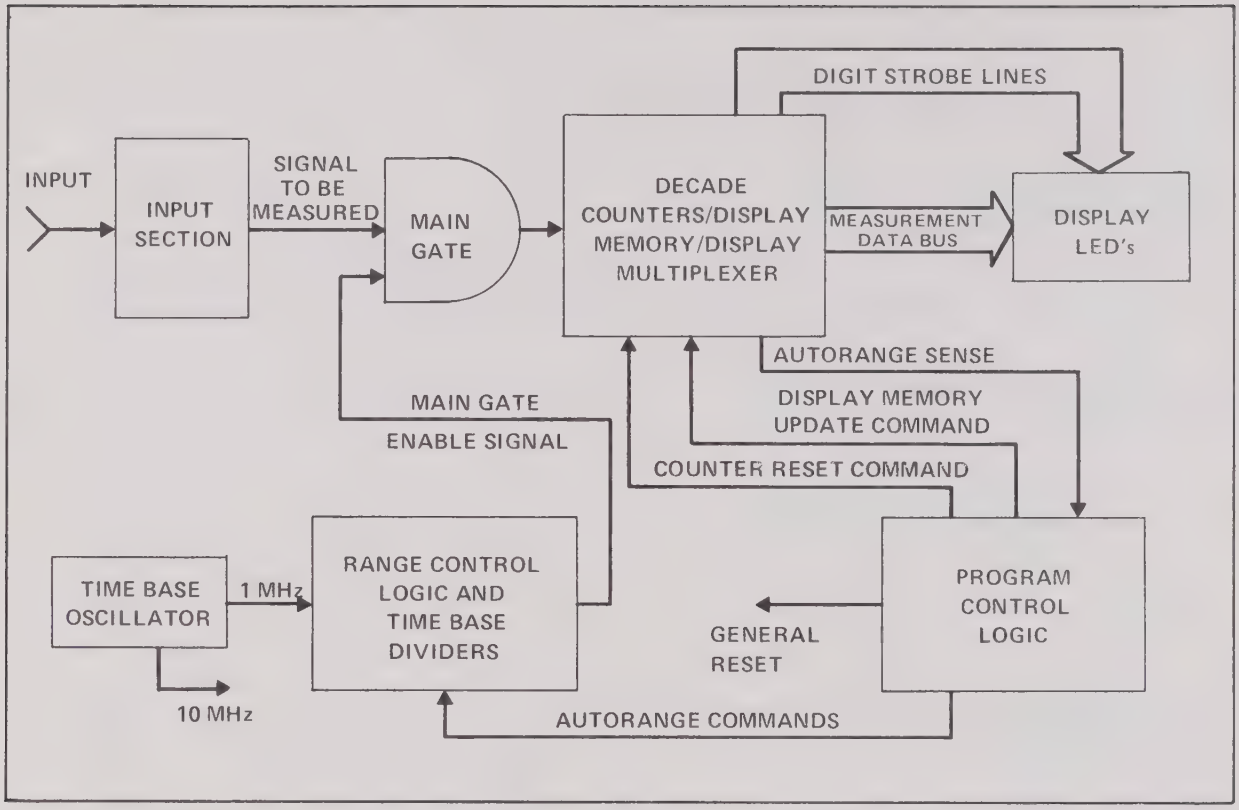

Figure 3-1. MODEL 1900A, SIMPLIFIED BLOCK DIAGRAM – FREQUENCY MODE

gram control section, begins with step 9. Refer to figure 3-2. Range logic is reset to the shortest gate time. A new measurement always begins with the shortest gate time. Any time a front panel switch is depressed, a new measurement is initiated by resetting the program control to step 9. The next event is general reset (GR), step 1. All the decade counters are set to 0 and the autorange logic is reset. Step 2 is skipped as only odd numbered steps are used to order events. At step 3 the time base dividers in the time base and the range control sections are enabled. The count is initiated by enabling the main gate to apply data to the first decade counter. The signal from the input section is applied to the clock input and toggles the counter. The output from the first counter is used to toggle the subsequent counters. At the end of the measurement period, the main gate is disabled and the count is held.

3-9. During step 5 the autorange logic decides whether or not the range is adequate for optimum resolution. If the most significant digit (MSD) is one or more, optimum resolution has been achieved. If the MSD is less than one, range control increases the gate time by a factor of ten. Manual selection of a range appears to the autorange logic as though the MSD is greater than one. Steps 7 and 9 are skipped and another count is taken in the new range. However, if in the previous measurement the MSD was equal to one, the second significant digit (2SD) must fall below 8 before a range change will be initiated This range hystersis prevents an unstable display if a measurement happens to vary a few cycles above or below MSD = 1. When a count is obtained with optimum resolution, the sequence may go on to step 7.

3-10. A memory update signal, MUP, occurs at step 7. The count obtained in step 5 is memorized for presentation to the display section. The display runs continuously. BCD digit information is strobed by the multiplexer from the memory on a data bus to the display. Six strobes are used, one for each digit. Each strobe enables one digit byte to be applied to the data bus and simultaneously enables the appropriate LED to light. MUP also enables the range logic conditions to be memorized by the decimal point logic. The decimal point logic decodes the range information and applies a pulse to the decimal bus during the correct strobe.

3-11. Range logic is reset to the shortest gate time during step 9. The measurement cycle is now complete and the instrument is ready to take a new measurement. Every new measurement starts with the shortest gate time.

3-12. Period Mode

3-13. The signal from the input section is applied to range control to derive the gate time in the period mode.

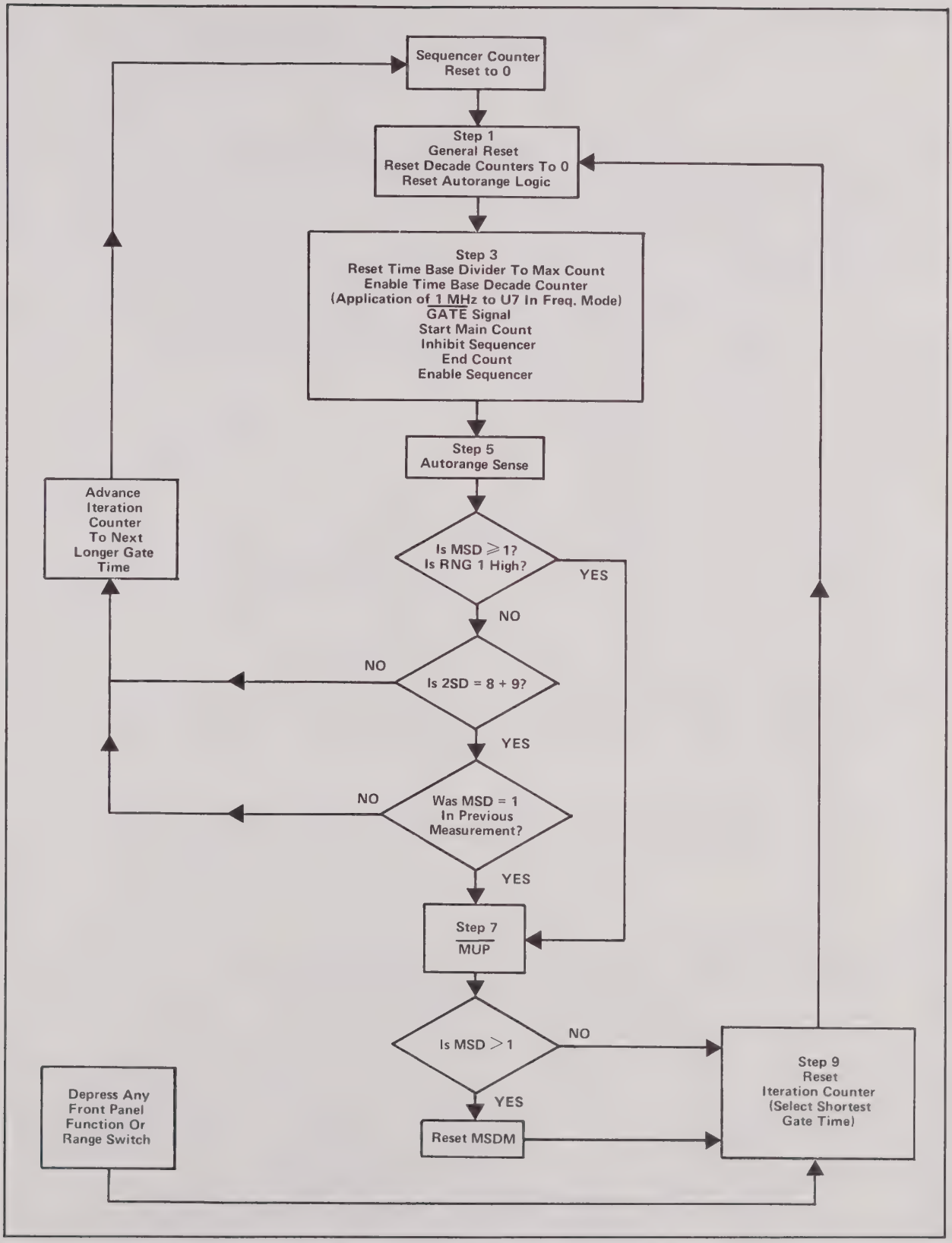

Figure 3-2. 1900A SEQUENCE FLOW CHART

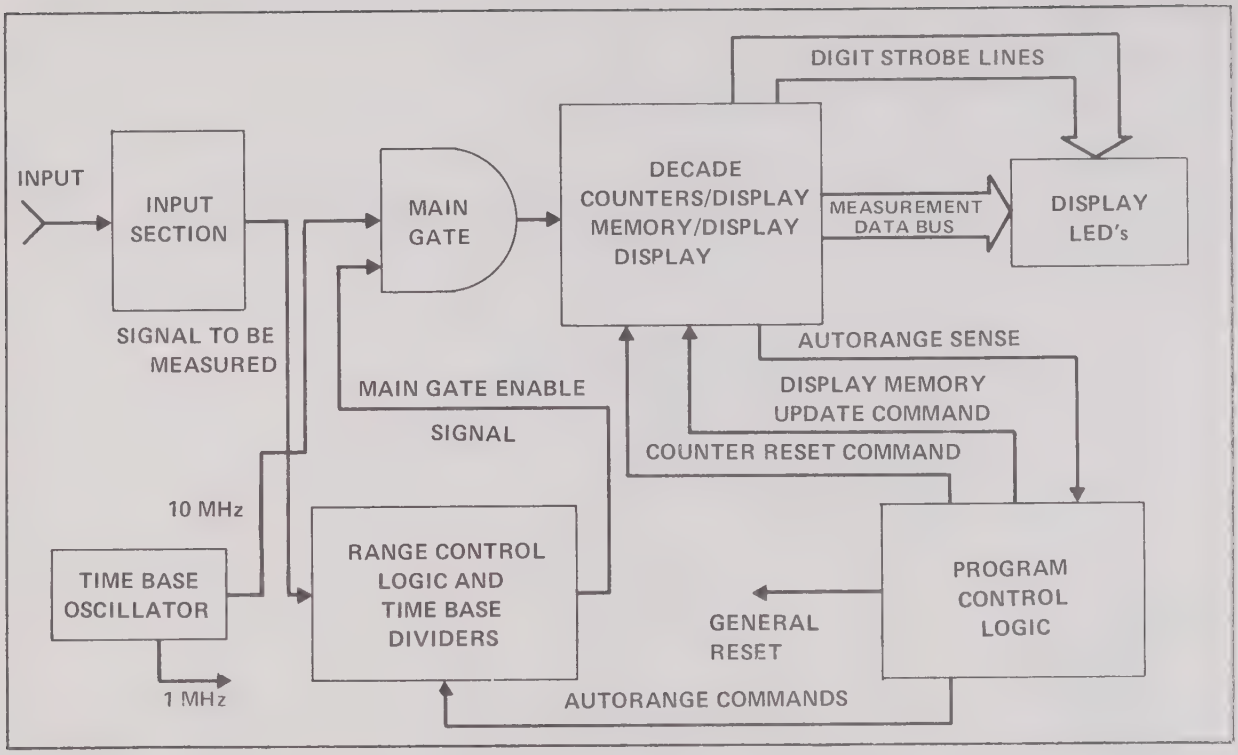

Figure 3-3. MODEL 1900A, SIMPLIFIED BLOCK DIAGRAM – PERIOD MODE

Refer to figure 3-3. Range control is programmed differently so that smaller division factors of ten are used in the period ranges. A 10MHz signal from the time base section is counted to determine how long the period is. The sequence of events is the same as in the frequency mode.

3-14. Totalize Mode

3-15. All range and program control functions are bypassed in the totalize mode. Refer to figure 3-4. The signal from the input section is applied to the first counter as in the frequency mode. However, the gate time is manually

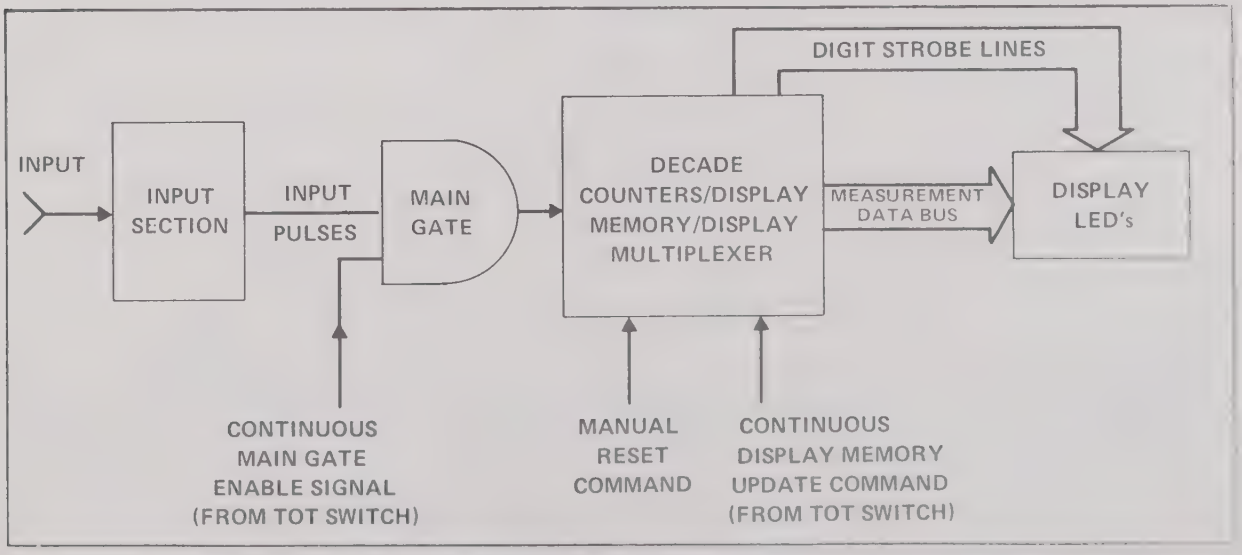

Figure 3-4. MODEL 1900A, SIMPLIFIED BLOCK DIAGRAM – TOTALIZE MODE

controlled. MUP is continuously enabled and the count is displayed as it is counted. The counter will count to 999999, when the overflow indicator lights and the count starts over. A new count may be initiated by depressing the reset switch.

3-16. Self Check Mode

3-17. In the self check mode the 1 MHz output from the time base section is used both as the derivation of the gate time and as the frequency to be counted. Refer to figure 3-5. In this mode the functioning of all parts of the instrument may be checked except the input section, the accuracy of the time base, and the time base dividers used in the period mode. The sequence of events and the operation of the circuitry is the same as in the frequency mode.

3-18. CIRCUIT DESCRIPTION

3-19. Introduction

3-20. Analysis of circuit blocks are contained in this section of the manual. Simplified schematic block diagrams are referred to by figure number. Information presented in tabular form is referred to by table number. Complete schematic diagrams are located in section 8. Circuit blocks must be analysed not only with respect to their internal operation but in relation to the sequence of events as explained under Frequency Mode. Figure 3-2 is a flow chart of the sequence of events in the 1900A.

3-21. Sequencer

3-22. The sequencer consists of a relaxation oscillator (U1), a decade counter (U2), and a decoder (U3). Refer to figure 3-6. Two sections of U1 are used to form the relaxation oscillator. R3 and C1 determine the frequency, approximately 100 Hz. U2 counts the oscillator frequency and presents the count to U3 in BCD form. Outputs from U3 are used to command events in the 1900A sequence. In all cases the output of U3 goes low to select an event. Step 1 is general reset (GR). The output of U3 is applied to a two-input NAND gate, one section of U5. The other input to the NAND gate is from the front panel switches through U1. If either input goes low, GR is initiated. The output of U5 is inverted twice to obtain the required GR and $\overline{GR}$ signals.

3-23. During step 3 the main gate is enabled. The $\overline{GATE}$ signal applied to a section of U5 inhibits the sequencer. $\overline{RMAX}$ from U3 inhibits the relaxation oscillator through CR1 and sets its output high so that at the end of $\overline{GATE}$, the counter will be toggled to the next step. Step 5 is autorange sense, step 7 is the memory update, MUP, and step 9 is the iteration counter reset, $\overline{ICR}$.

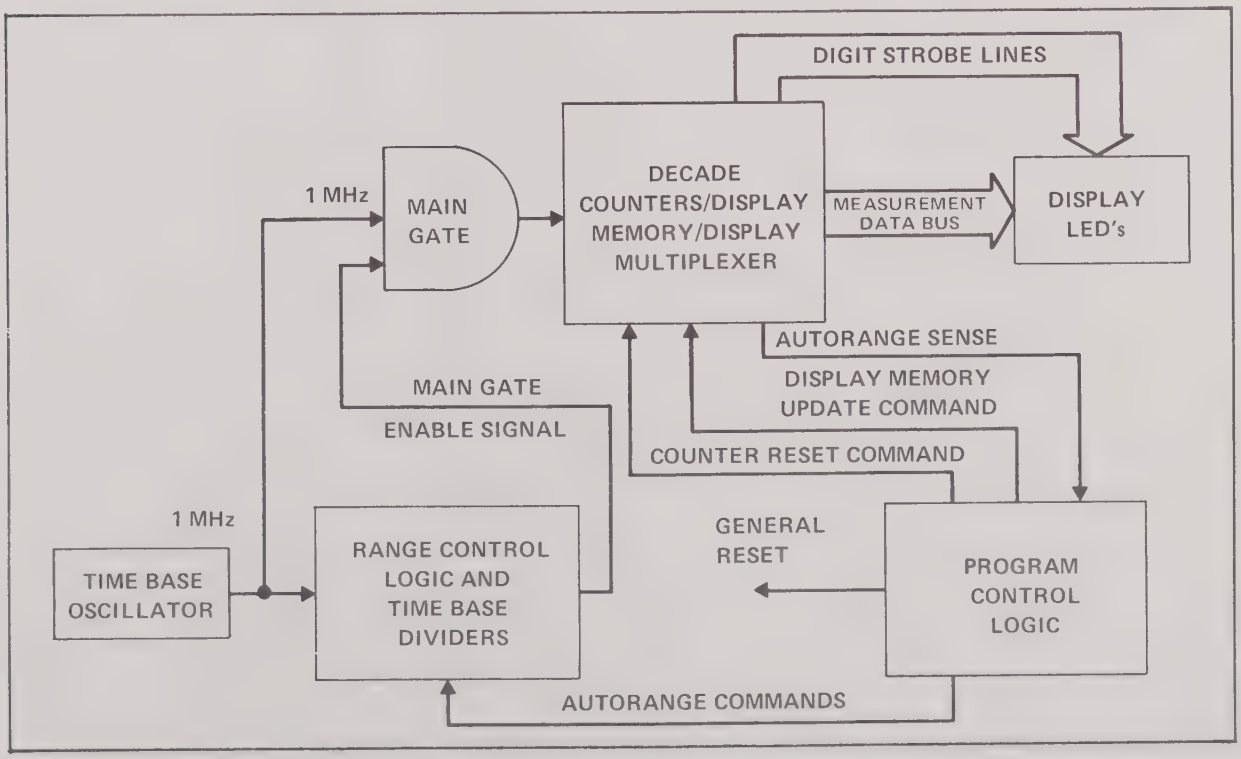

Figure 3-5. MODEL 1900A, SIMPLIFIED BLOCK DIAGRAM – SELF-CHECK MODE

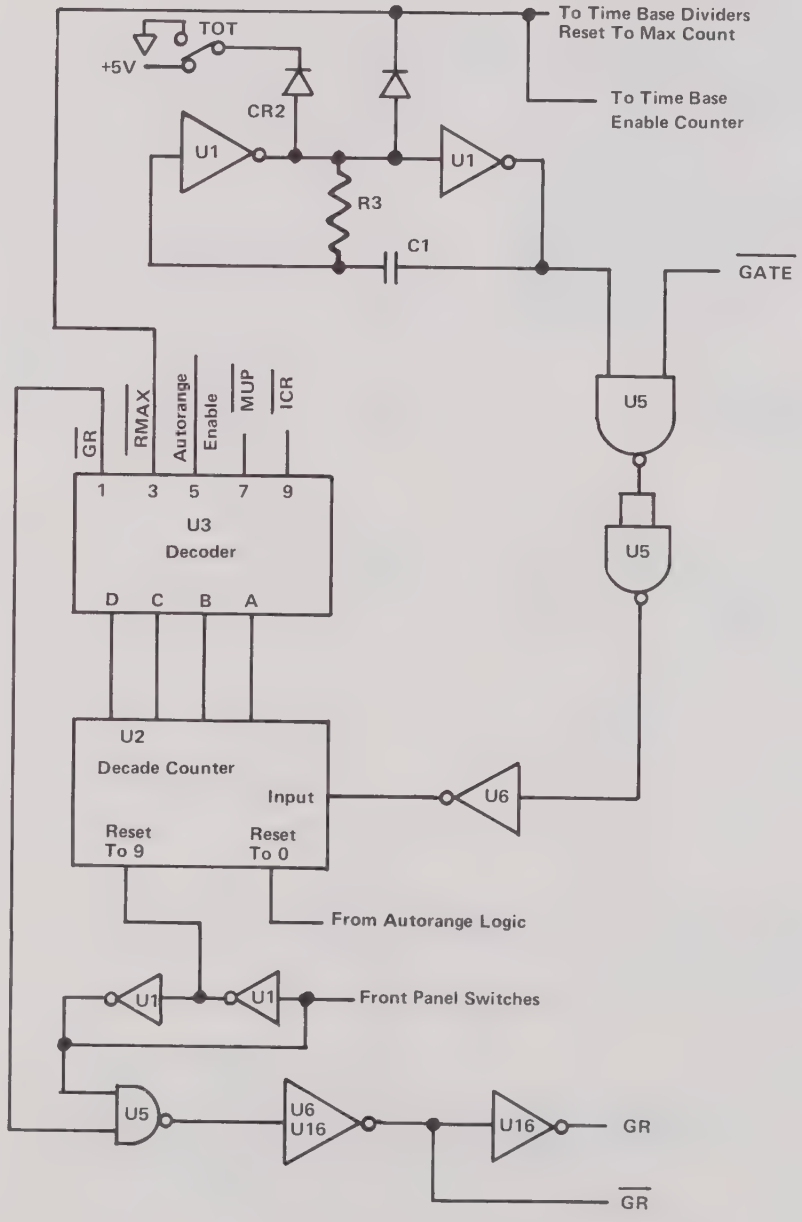

Figure 3-6. SEQUENCER

3-24. Input Section

3-25. An input signal from the BNC connector is coupled through C1 to buffer amplifier, Q1 and Q2. Refer to figure 3-7. The output of the buffer is applied to the emitters of Q3 and Q4. Attenuator switch, S1A, controls the biasing of Q3 and Q4. Q3 passes the signal unattenuated and Q4 passes the signal attenuated by R6 and R7. With the filter switch out, CR7 and CR8 are biased off and no filtering occurs. When CR7 and CR8 are biased on, C6 provides a low impedance path to ground for frequencies above 1 MHz. The first section of U1 is a comparator amplifier whose triggering sensitivity is controlled by R14. The second section of U1 is an amplifier which drives the third section, a schmitt trigger. The output amplifier consists of Q5, Q6, and Q7 which further squares the signal and converts it to TTL levels.

3-26. Main Gate/Decade Counters

3-27. At step 3 in the sequence, a gate pulse ($\overline{GATE}$) is generated by the range control logic. $\overline{GATE}$ is applied to one input of the main gate, U17. Refer to figure 3-8. The other main gate input is connected to the totalize (TOT) switch, S5C. If either input to U17 goes low, its output goes high. This presents a logic 1 to the J and K inputs of the first flip-flop in the LSD decade counter. The input signal is applied to the clock input of the decade counter and toggles the counter on the negative-going edge of the pulses. The output of the first counter is applied to U24 on

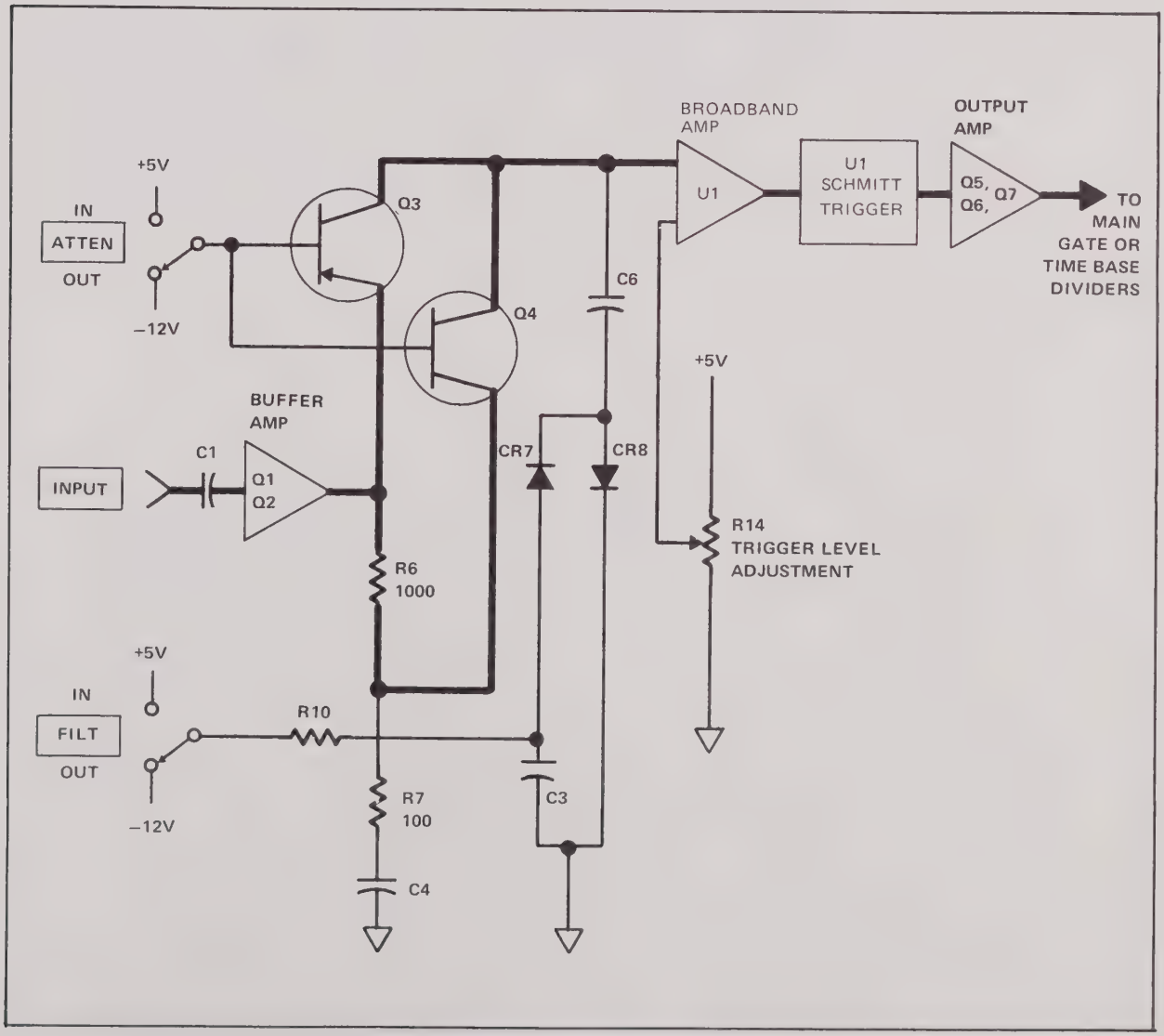

Figure 3-7 INPUT SECTION, BLOCK DIAGRAM

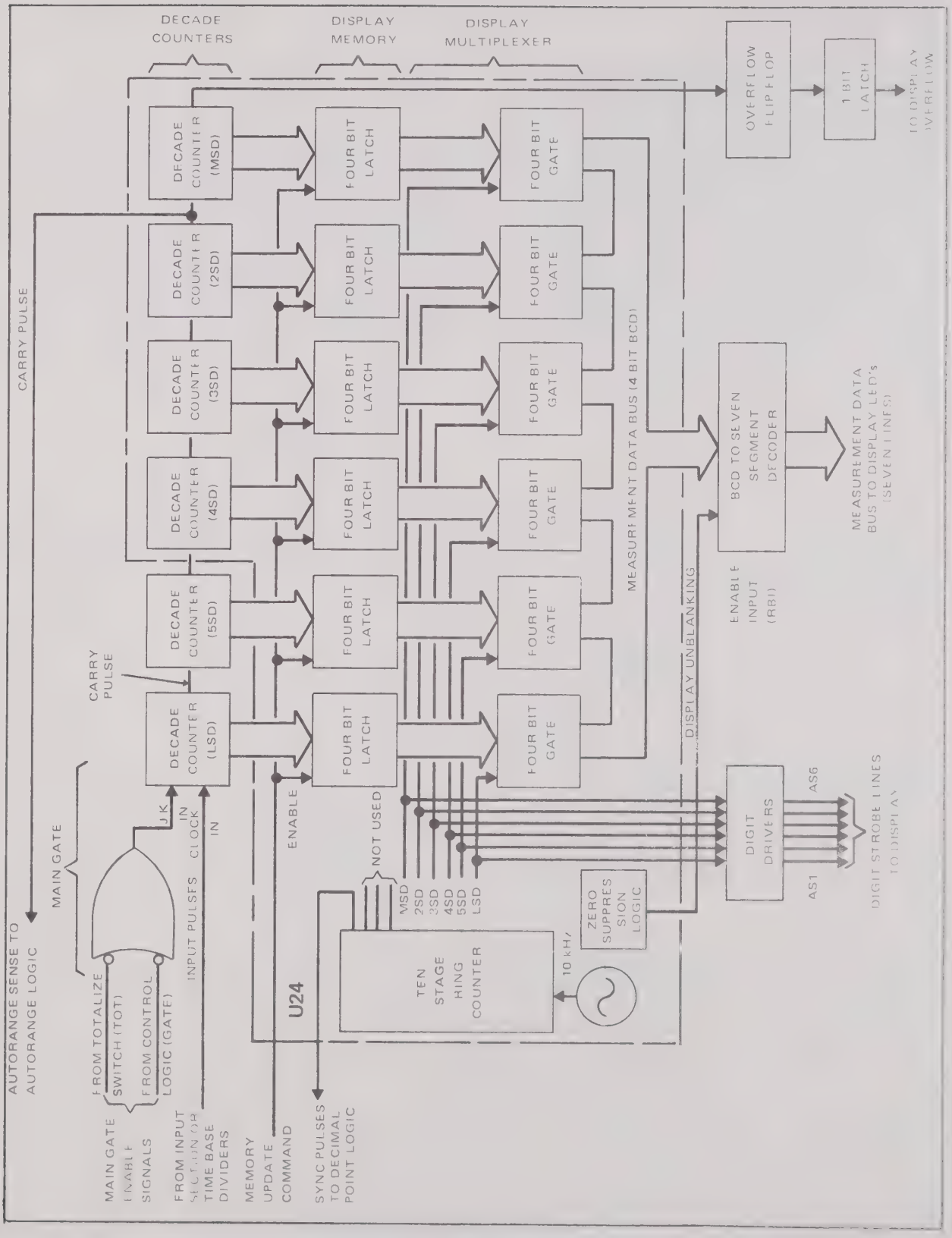

Figure 3-8. DECADE COUNTERS, DISPLAY MEMORY & DISPLAY MULTIPLEXER BLOCK DIAGRAM

four BCD lines, A, B, C, and D. The D output is also applied to the next counter (5SD). The LSD and 5SD counters are seperate ICs. The rest of the counters along with the display memory, display multiplexer, and a ring counter used to develop strobe signals are contained in U24. The fourth or D line from a counter, which is applied to the next counter, goes high when its count reaches 8 and falls low on the tenth count. The trailing edge so generated clocks the next counter. At the end of $\overline{\text{GATE}}$ both inputs to U17 are high and its output goes low. With a 0 applied to the J and K inputs of the first flip-flop, the clock input is ignored and counting ceases. The counters hold the count until GR during step 1.

3-28. Display Memory and Multiplexer

3-29. When step 7 is reached, the sequencer generates a memory update (MUP) signal. Refer to figure 3-8. At that time the contents of the decade counters are memorized in four-bit latches. A 10 kHz oscillator and 10 stage ring counter inside U24 generate strobe signals used by the display multiplexer. The multiplexer consists of a four-bit gate for each latch in the display memory. The gates are sequentially enabled by the strobe signals to apply the contents of the memory latches onto the common measurement data bus, four BCD lines. Information on the measurement data bus is decoded by a seven-segment decoder for application to the display.

3-30. Display

3-31. The display consists of six seven-segment LEDs and three annunciators. Refer to figure 3-9. Decimal LEDs are contained in the seven-segment LEDs. At the same time a strobe signal enables a gate in the display multiplexer, it enables the appropriate LED. Although the digit information is applied to all the LEDs, only one will light at a time. An LED will only be on, then, for a period of 90 μseconds, allowing a 10 μsecond guard space between digit strobes. Decimal information and signals for two of the annunciators come from the decimal point logic as will be explained later. The overload annunciator is lit by an inverted signal from U24 when the count exceeds the capacity of the display.

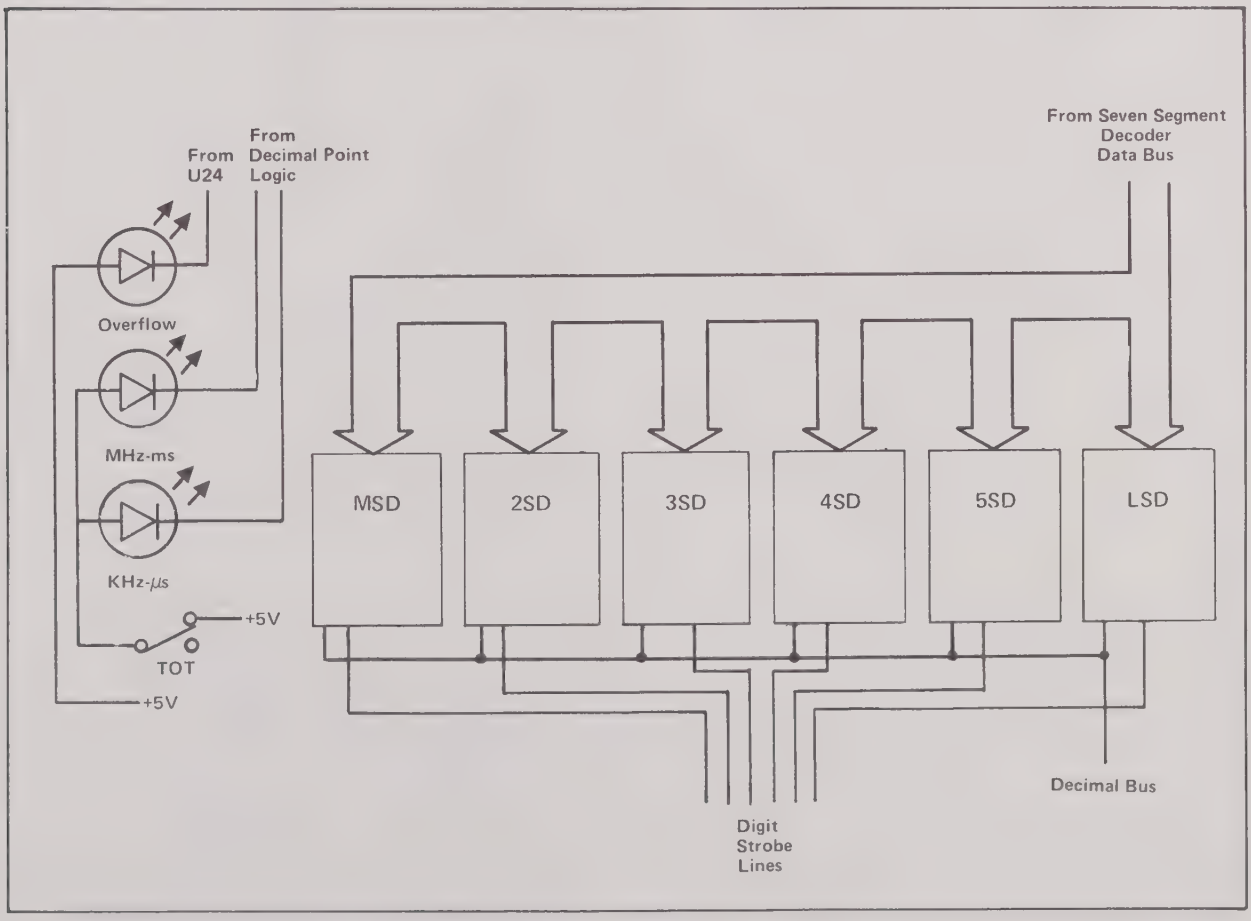

Figure 3-9. DISPLAY

3-32. Time Base

3-33. The time base section consists of a 10 MHz oscillator, a buffer amplifier (Q15), a NAND gate (U17), and a decade counter (U12). Refer to figure 3-10. Q16 is configured as a colpitts oscillator whose frequency is controlled by crystal Y1. Buffer amplifier, Q15, drives the NAND gate, U17, which provides further buffering. U12 divides the 10 MHz oscillator signal by ten to obtain the 1 MHz time base. U12 is held reset to 0 by the RMAX output from the sequencer being high. During step 3 of the sequence RMAX goes low and enables U12 to count. In the frequency and self-check modes the 1 MHz output from U12 is applied to the time base dividers of the range control logic. It is also the frequency counted in the self-check mode. In the period mode the 10 MHz output from the time base is the frequency counted. 10 MHz is used to optimize resolution when measuring short periods.

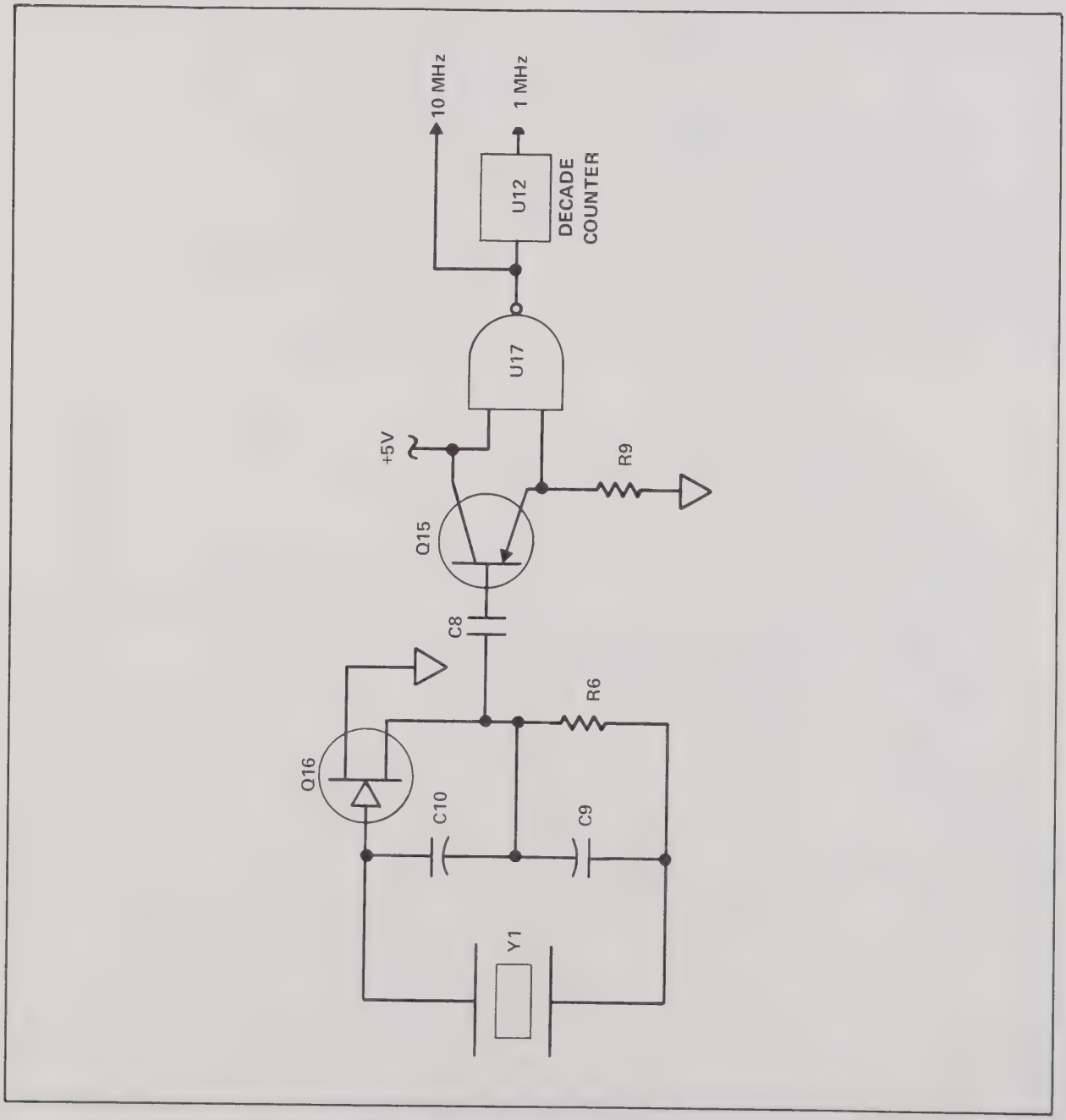

Figure 3-10 TIME BASE OSCILLATOR, BLOCK DIAGRAM

3-34. Range Control Logic

3-35. Range control logic consists of the range switches, an iteration counter (U13), time base dividers (U7), and a gate time flip-flop (U8). Refer to figure 3-11. The range switches program the iteration counter through four NAND gates (U18). The outputs of U18 are connected to the set and reset inputs of U13. When all inputs to U18 are high, all outputs are low, and the iteration counter will respond to a clock input from the autorange logic. For manual range programming, a range switch places a 0 on two inputs of

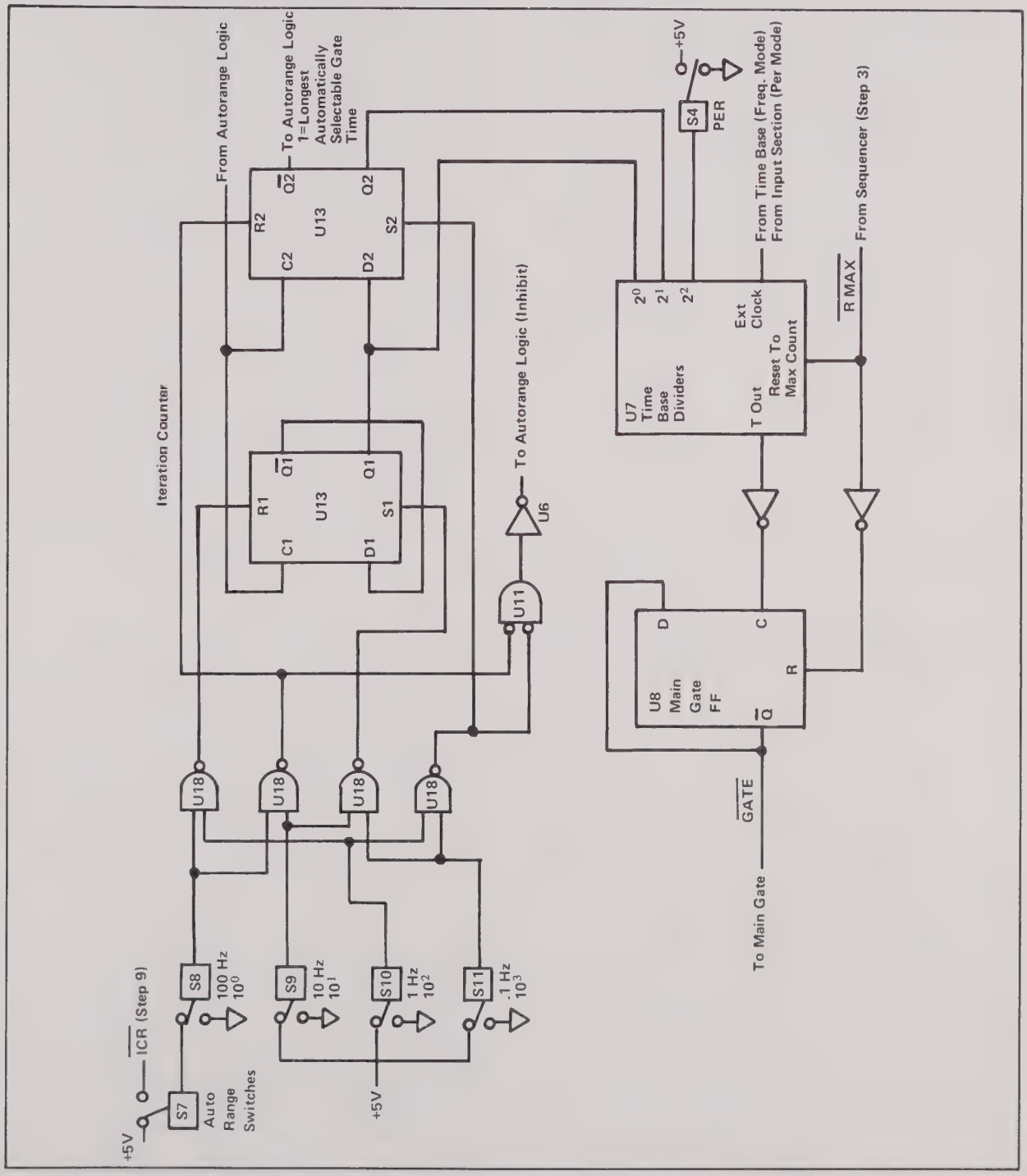

Figure 3-11. RANGE CONTROL LOGIC

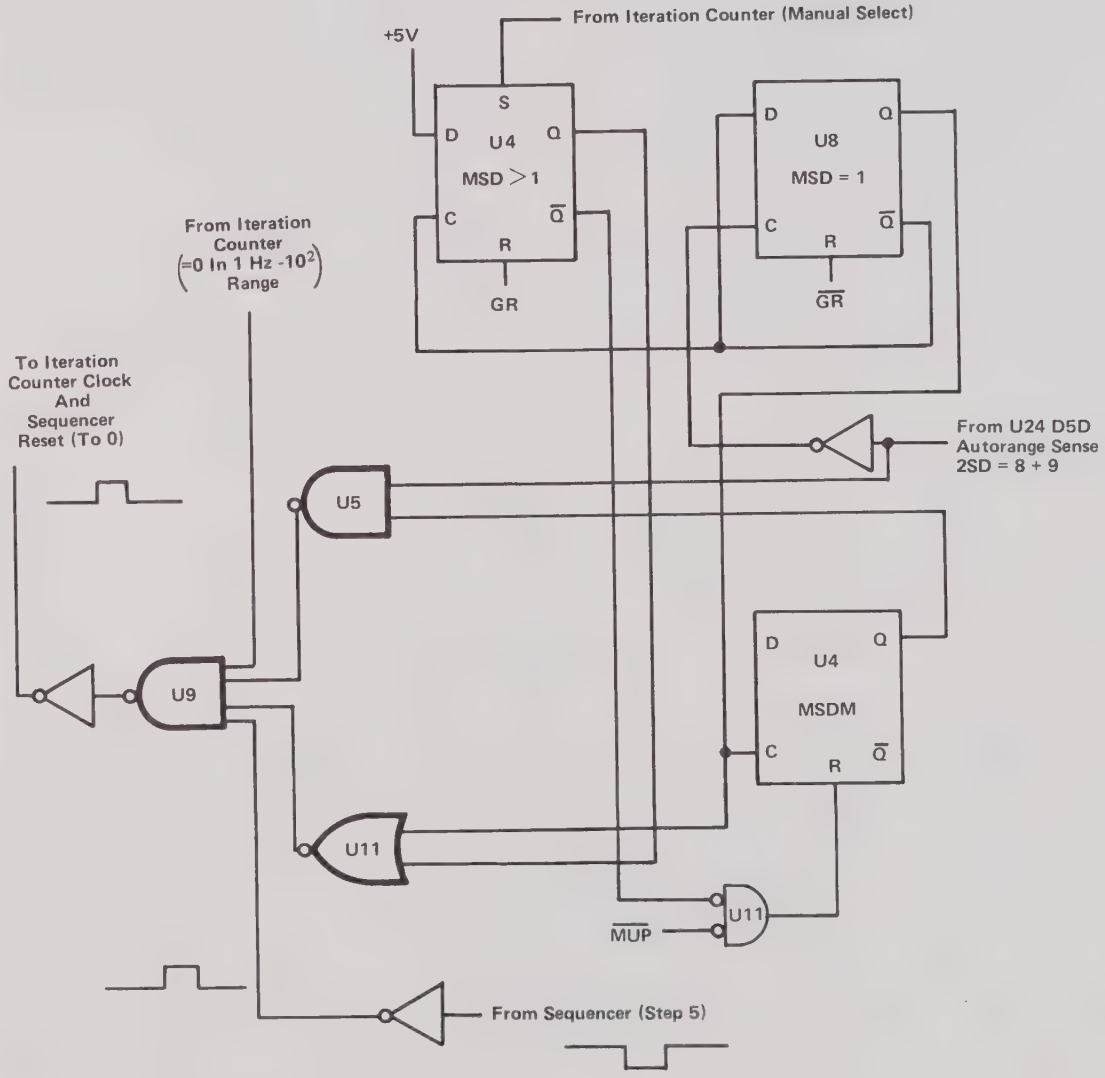

Figure 3-13. AUTORANGE LOGIC

Section 4
Maintenance

4-1. INTRODUCTION

4-2. This section contains information concerning preventive and corrective maintenance for the Model 1900A Multi-Counter. A maintenance interval of one year for calibration is recommended to ensure instrument operation within the one year specifications. Equipment for performing maintenance tests and adjustments is listed in Table 4-1. If this equipment is not available, other equipment having equivalent specifications may be used.

NOTE

When greater than one year accuracy is required, refer to specifications for timebase aging rate to determine the re-calibration interval required to maintain desired accuracy.

4-3. SERVICE INFORMATION

4-4. Should your instrument need repair, send it to the nearest factory authorized service center. A list of these authorized service centers is located in section 7. Located on the inside front cover is the WARRANTY which warrants the instrument for a period of one year. of one year.

4-5. GENERAL MAINTENANCE

4-6. Access

4-7. Use the following procedure to gain access to the interior of the Model 1900A.

a. With the power switch OFF, disconnect the line cord.

b. Remove the Phillips screw at the rear of the instrument case.

c. Remove the instrument from the case.

4-8. Cleaning

4-9. Clean the front panel and case with denatured alcohol or mild solution of detergent and water. Do not use aromatic hydrocarbons or chlorinated solvents because they will react with the plastic materials of the instrument.

4-10. Fuse Replacement

4-11. The input power fuse, F1, is located within the instrument in a fuse clip near the power transformer (T1). To gain access to the fuse, refer to paragraph 4-6. When replacement is required, install AGC 1/4A (fast acting) for line powered instruments. Use MDA ½A (slow blow) for battery powered instruments.

4-12. PERFORMANCE CHECKS

4-13. The performance checks provide a means of verifying overall operation of the Model 1900A. The checks can be used as an acceptance check during incoming inspection or as a periodic maintenance check. Refer to Table 4-1 for a list of required test equipment. Equivalent equipment may be used.

4-14. Functional Check

4-15. To perform a functional check of the Model 1900A, refer to the self-check described in Section 3.

4-16. Sensitivity Check

4-17. Perform the sensitivity checks as follows:

Table 4-1. TEST EQUIPMENT REQUIRED FOR PERFORMANCE TEST, CALIBRATION AND TROUBLESHOOTING

EQUIPMENT NOMENCLATURE	RECOMMENDED MODEL	WHERE USED
Quartz Oscillator Frequency Standard with 10 MHz Output	HP 105B *	Timebase Oscillator Adjustment
Low-Frequency Oscillator	HP3325 *	
High-Frequency Oscillator	HP8656B or Equiv.*	
RF millivoltmeter with 50Ω terminator		Sensitivity Check
Multimeter		Troubleshooting
Oscilloscope		Troubleshooting

* Modified 2-5-92 EC

a. Connect the low frequency generator, set for 5 Hz at 25mV, to the 1900A input.

b. Energize the counter and depress the FREQ function switch and AUTO resolution switch.

c. Confirm that the counter display indicates .005 kHz ± 1 digit.

d. Disconnect the low frequency generator from the input.

e. Connect the high frequency generator, terminated into 50 ohms, to a T-connector on the 1900A input. Set the generator output for 10 MHz at approximately 25mV rms.

g. Connect the RF millivolt meter to the T-connector on the input of the 1900A.

h. Adjust the high frequency generator output for a reading of exactly 25mV on the RF millivolt meter.

i. Confirm that the counter display indicates 10.0000 MHz ± generator accuracy.

j. Change the generator output to 80 MHz at exactly 25mV.

k. Confirm that the counter display indicates 80.0000 MHz ± generator accuracy.

4-18. CALIBRATION

4-19. Calibration of the Model 1900A is limited to adjustment of the trigger level and time base oscillator frequency.

4-20. Trigger Level Adjustment

4-21. Trigger level adjustment should be performed whenever repairs have been made to the input section of the counter. The input section comprises that circuitry contained on the input printed circuit board assembly. Perform trigger level adjustment as follows:

a. Remove the counter from the case (paragraph 4-6)

b. Energize the counter and connect the high-frequency oscillator to the counter input.

c. Select an output of 25 mV rms at approximately 80 MHz on the oscillator.

d. Adjust the trigger level control (R14) to a midpoint which produces a stable display near 80 MHz.

e. Reduce the signal level until the display becomes unstable.

f. Re-adjust the trigger level control until the display is again stable.

g. Repeat steps e and f until no additional sensitivity increase is possible.

4-22. Time-Base Oscillator Adjustment

4-23. Time base oscillator adjustment should be made whenever the oscillator is repaired, or whenever it is determined that accuracy of the counter is not within the accuracy desired. Perform time base oscillator adjustment in an environment having an ambient temperature of +22°C to +25°C (72°F to 77°F). Allow the instrument to warm up at least 30 minutes with the case on before adjusting the time base.

4-24. Timebase Adjustment Using A Frequency Standard

a. Remove the counter from the case (paragraph 4-6)

b. Energize the counter and select the FREQ function and 10 Hz resolution.

c. Select a 10 MHz output on the quartz oscillator and connect the 10 MHz signal to the counter input.

d. While observing the counter display, adjust the time base oscillator control (C11 located on the main pcb directly behind the reset switch) to obtain a reading of 000000 ± 1 digit.

4-25. TROUBLESHOOTING

4-26. Introduction

4-27. The following information is designed as an aid in troubleshooting the 1900A multi-counter. Figures 4-2 to 4-6 are flow charts directed toward specific problems. Figure 4-1 shows the location of test points and table 4-2 gives the electrical location of the test points and what to expect at each point. Theory of Operation, section 3, and repair techniques, later in section 4, should be read and understood before attempting to troubleshoot the instrument.

4-28. Initial Troubleshooting

4-29. Thoroughly inspect the unit for physical damage such as broken parts, shorted leads, or other visually discernible problems. Recheck input connections and switch settings to be sure the problem actually is in the 1900A.

4-30. Power Supply

4-31. The power supplies should be checked first in the event of a 1900A malfunction. Remove the case as described in paragraph 4-6. Apply ac power. Test point 1 is the +5V regulated supply. Its limits for the line version are +4.75V to 5.25V with no more than 100mV p-p ripple. With the battery option the limits are +4.5V to 5.5V with no more than 500mV p-p ripple. Test point 2 is the -12V supply whose limits are -10.5V to -12.0V with no more than 100mV p-p ripple for either version.

4-32. Fault Isolation

4-33. Perform the self-check as described in section 2. Observation of the symptoms evident in the self-check mode should provide clues as to the location of the problem. If the unit performs the self-check satisfactorily the problem is probably in the input section. If the problem is decimal point related, the operation of the iteration counter and decimal point logic should be checked. No display or a missing digit probably indicates U23 or U24. Missing segments in the display probably indicates U23 or one or more faulty LEDs. No counting action or an erroneous count probably indicates program control, time base, or main gate/decade counter problems.

4-34. Input Section

4-35. Apply a 1V p-p signal to the 1900A BNC connector. Choose a frequency which has good waveform resolution on the oscilloscope. At the gate of Q1 the signal should be .5V p-p with no distortion (the voltage levels given are approximate). Distortion of the input, visible at the gate of Q1, begins at about 4V p-p input level. The emitter of Q3 should have 1.5V p-p as should pin 10 of U1. Depressing the FILT switch (looking at pin 10 of U1) should diminish the level slightly even at low frequencies. The roll-off of the filter is gradual. Succeeding waveforms are square waves with a spike on the leading edge. Outputs from U10 (pins 7, 3, 15) are approximately 1.25V p-p. The output of the input section (TP4) should be a square wave with spikes on the leading edge going positive from near OV to +5V.

4-36. Time Base

4-37. The voltage on the base of buffer Q15 should be about 9V p-p. TP3 should have 6V p-p of a moderately distorted sine wave. The output of U12 is a square wave with a spike on the trailing edge and ripple on the top of the waveform.

4-38. Sequencer

4-39. The output of the relaxation oscillator should be a 5V square wave. A differentiated square wave, about 10V in amplitude should be at pins 5 and 6 of U1. TP8 is a 5V square wave. The frequency of the relaxation oscillator should be around 100 Hz, interrupted by the duration of the gate signal. The outputs of U3 are normally at +5V and go low to near OV to select an event.

4-40. Control Logic and Counters.

4-41. To check the iteration counter, manually select the ranges and check the outputs against table 3-2. Troubleshooting the rest of the circuitry is best accomplished by checking for output pulses from the circuitry sections, keeping in mind the oscillator which governs the duration of the pulse and the place of the pulse in the sequence.

4-42. REPAIR TECHNIQUES

4-43. Battery-Powered Instruments

4-44. In battery-powered instruments, one of the batteries should be removed before attempting any repair. This is necessary to eliminate the danger of shorting portions of the circuitry which carry the battery voltage. Remove the battery as described in Section 6.

4-45. Integrated Circuit Replacement

4-46. Three types of integrated circuits are used in the Model 1900A, as listed in Table 4-3. The handling of TTL types require no special handling. However, the CMOS and PMOS types can be destroyed by a static electricity discharge. To prevent damage due to static discharge, the following precautions should be taken whenever this type of integrated circuit is handled:

a. The PMOS or CMOS integrated circuit is packed in conductive foam. Do not remove the conductive foam from the integrated circuit until ready for installation into the unit.

b. Be sure the repairing personnel and the unit under repair are commonly grounded.

c. Be sure the soldering iron used is grounded to the common ground.

Table 4-2. TEST POINT DESCRIPTIONS

TEST POINTS	ELECTRICAL LOCATION	DESCRIPTION
1	+5V reg.	+4.75V to +5.25V (≤100mV ripple) line. +4.5V to +5.5V (≤500mV ripple) –01 Option
2	–12V	–10.5V to –12.0V (≤100mV ripple)
3	U17	Timebase 10 MHz Sine, moderately distorted
4	Output of Input PCB	OV to +5V Square wave
5	U6 & U16	$\overline{GR}$ +5V to OV pulse
6	U19	GR OV to +5V pulse
7	U8 (1)	Gate time flip-flop ($\overline{GATE}$) +5V to OV pulse
8	U2	Clock input to sequencer OV to +5V pulses
9	U4 (1)	MSDM flip-flop OV to +5V when MSD ≥1
10	U23	Display LED segment test ground to test all segments (except decimals)

Table 4-3. MODEL 1900A INTEGRATED CIRCUIT TYPES.

REFERENCE DESIGNATOR	TYPE	REFERENCE DESIGNATOR	TYPE	REFERENCE DESIGNATOR	TYPE
U1	CMOS	U10	CMOS	U19*	TTL
U2*	TTL	U11	CMOS	U20*	TTL
U3*	TTL	U12*	TTL	U21*	TTL
U4	CMOS	U13	CMOS	U22	CMOS
U5	CMOS	U14	CMOS	U23*	TTL
U6	CMOS	U15	CMOS	U24	PMOS
U7	PMOS	U16	CMOS	U25	R
U8*	TTL	U17*	TTL		
U9	CMOS	U18	CMOS		

* For -01 Battery Option, low power TTL devices are being used and consistency should be maintained. See Section 5 for part numbers and serial number effectivity.

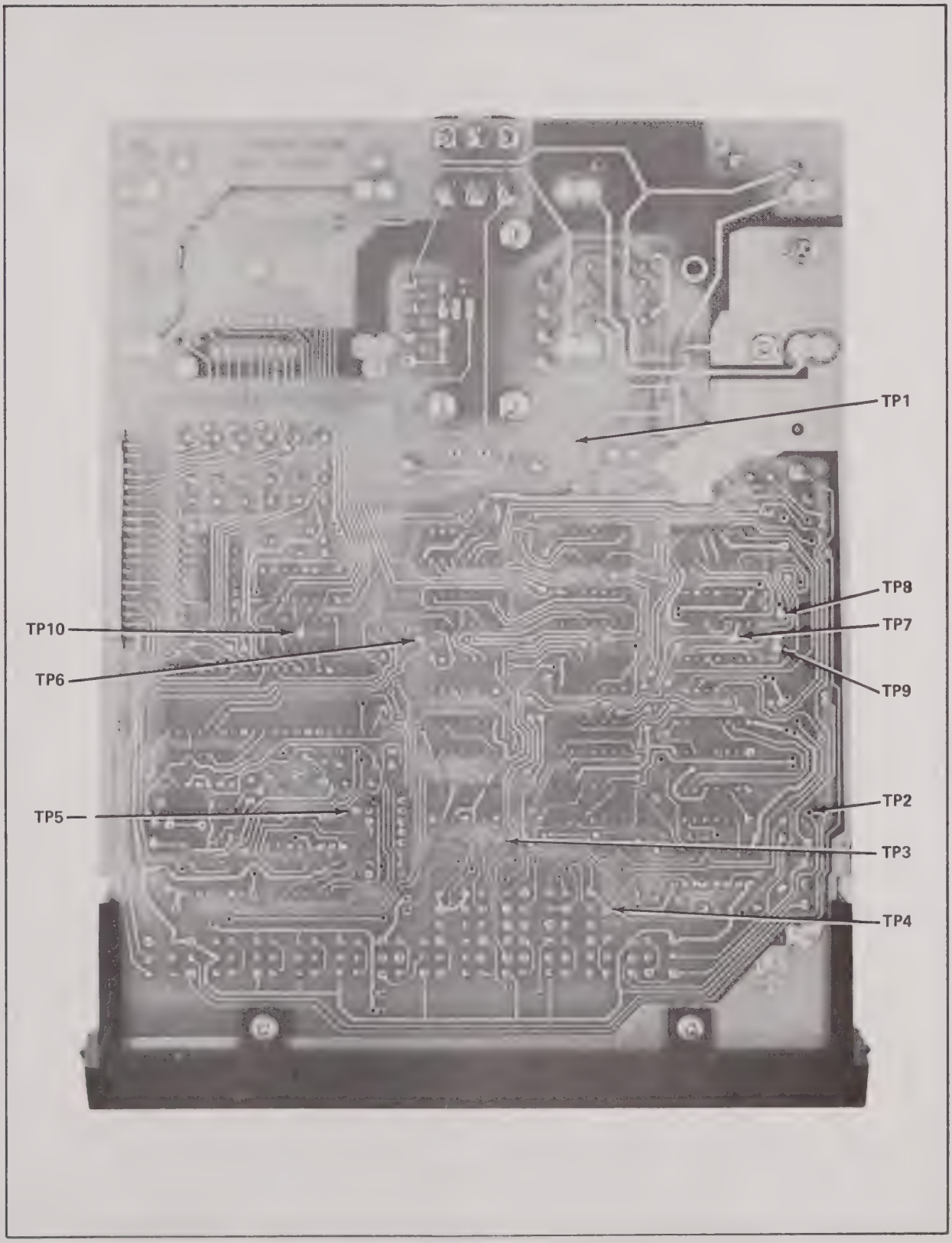

Figure 4-1. TEST POINT LOCATIONS

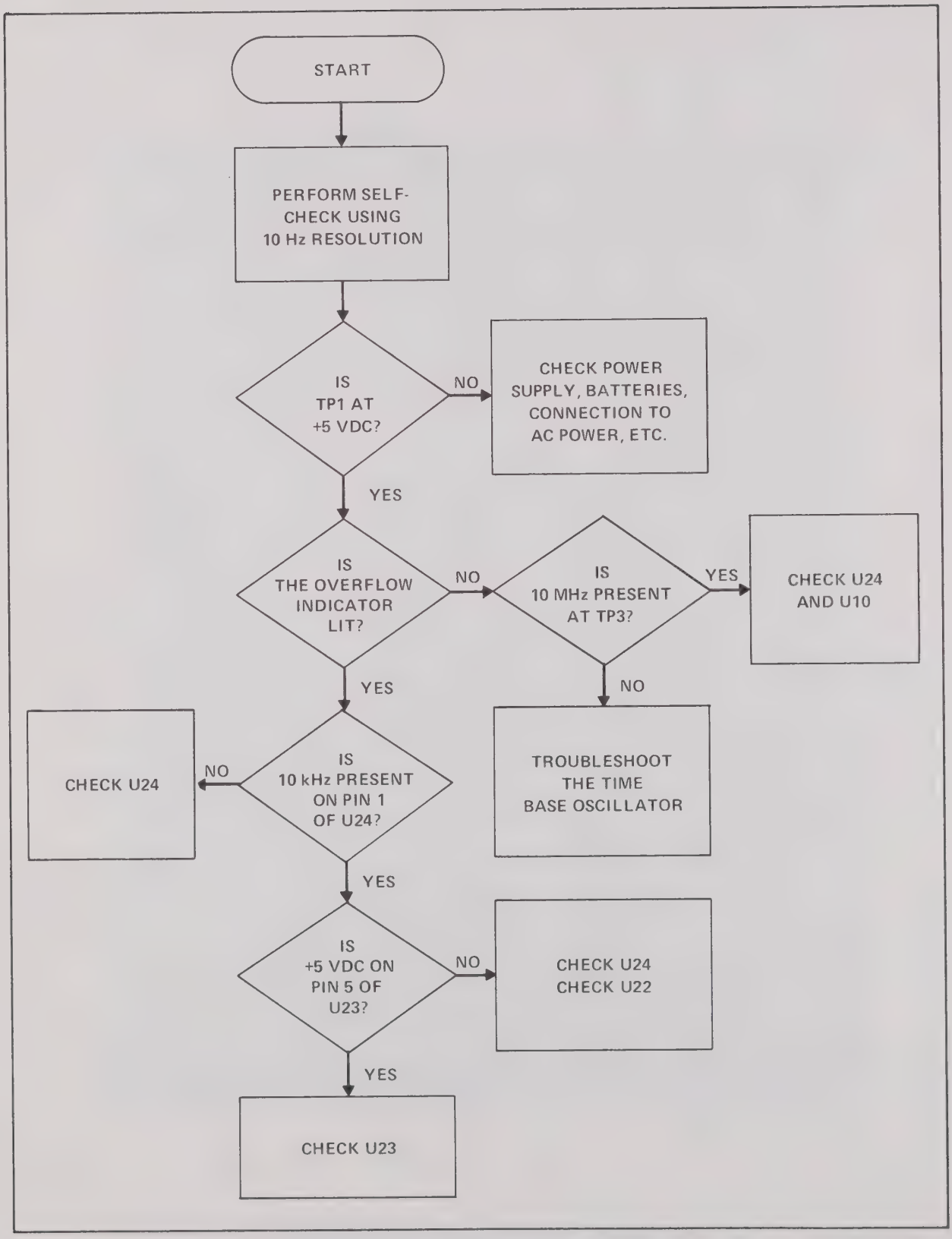

Figure 4-2. FAULT ISOLATION – NO DISPLAY

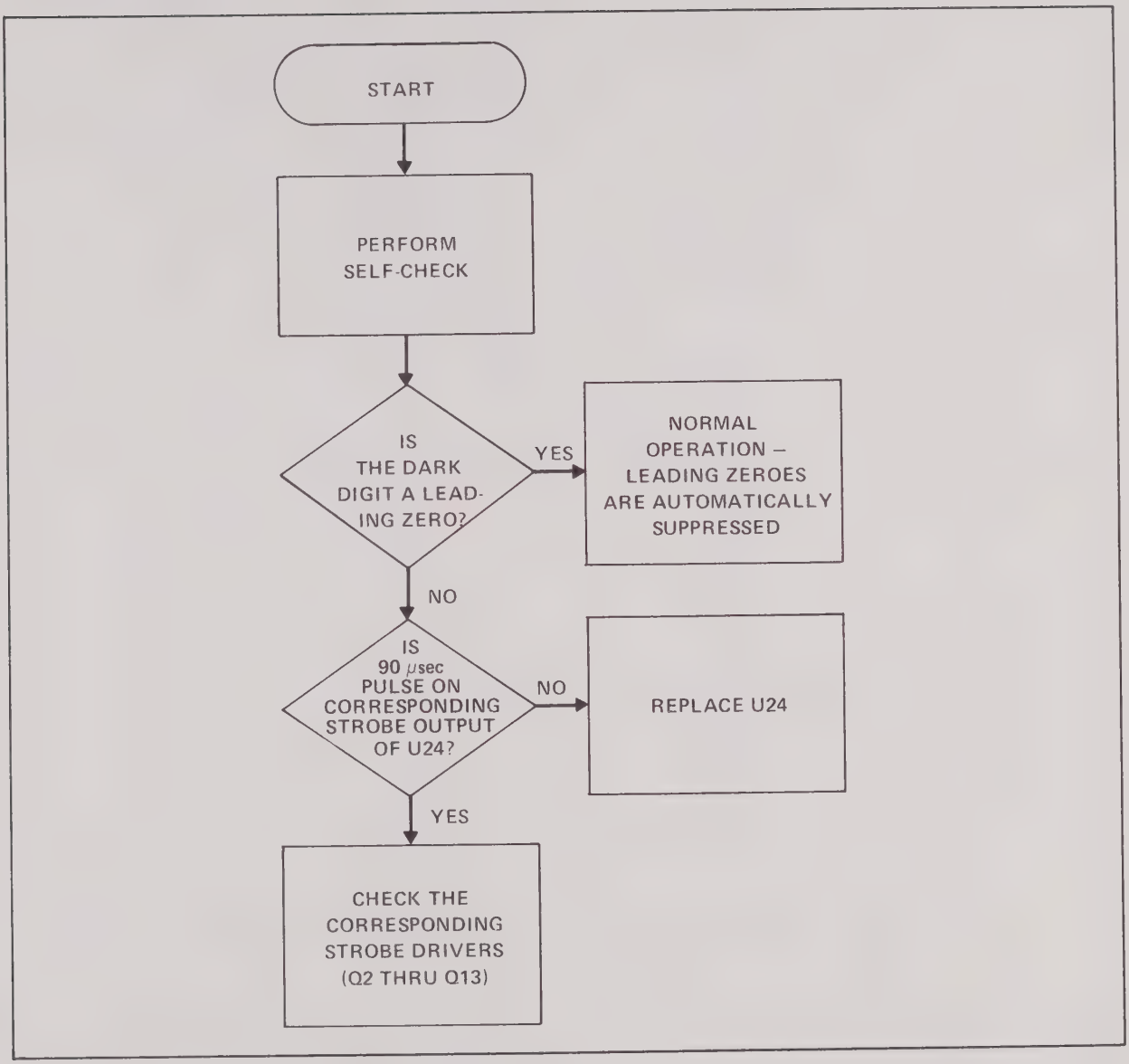

Figure 4-3. FAULT ISOLATION – ONE DARK DIGIT

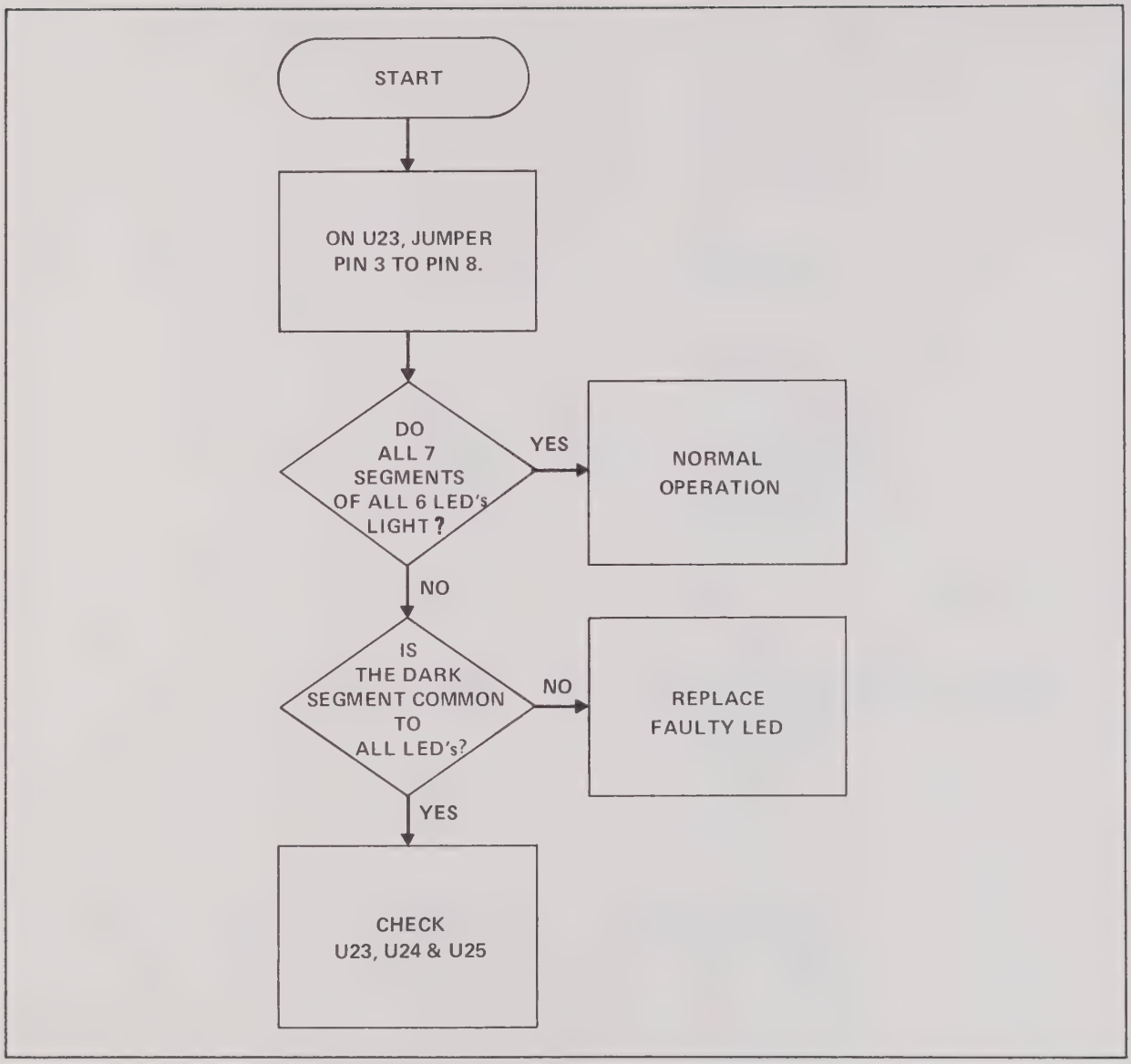

Figure 4-4. FAULT ISOLATION – DARK LED SEGMENT

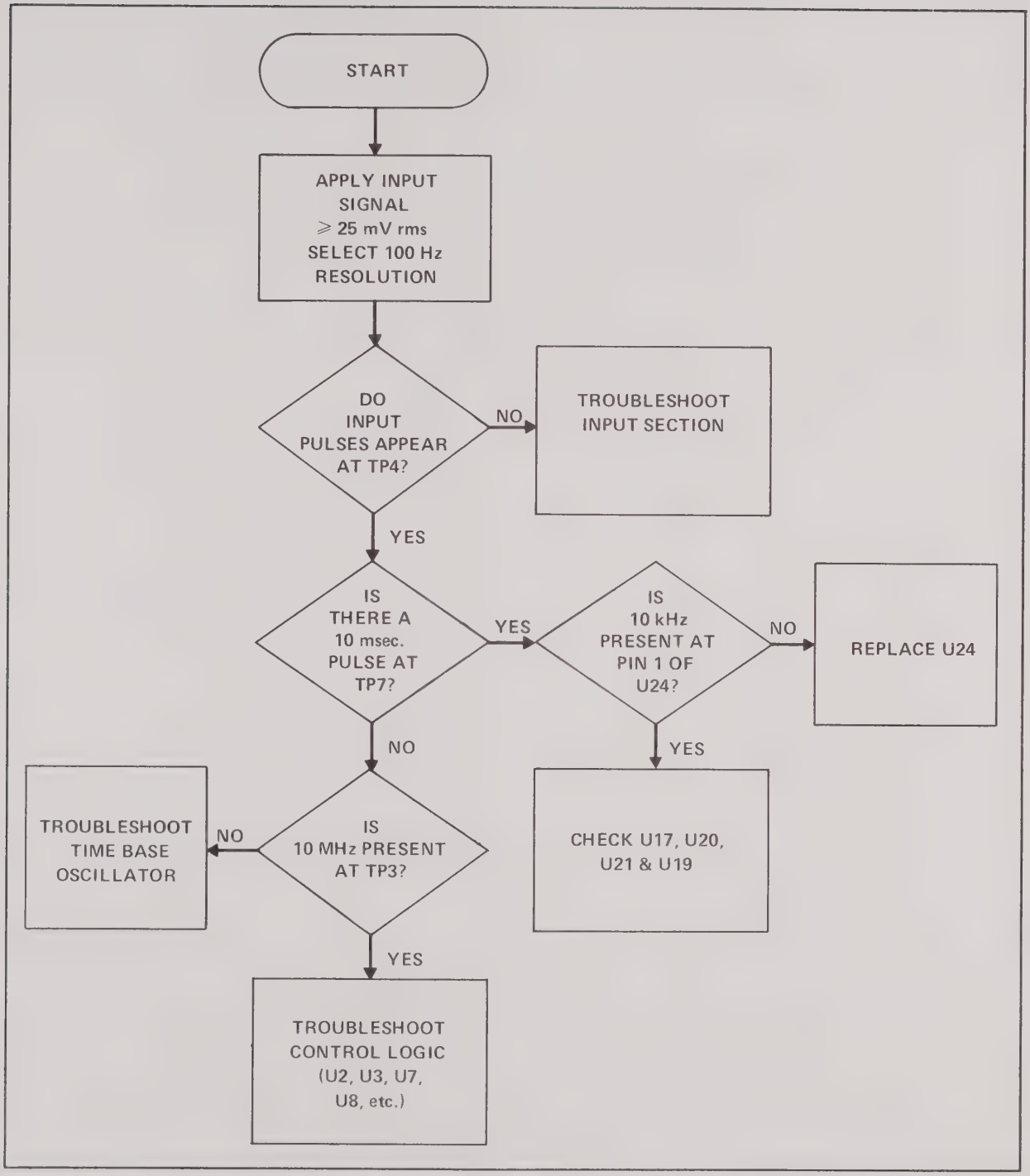

Figure 4-5. FAULT ISOLATION -- NO COUNTING ACTION

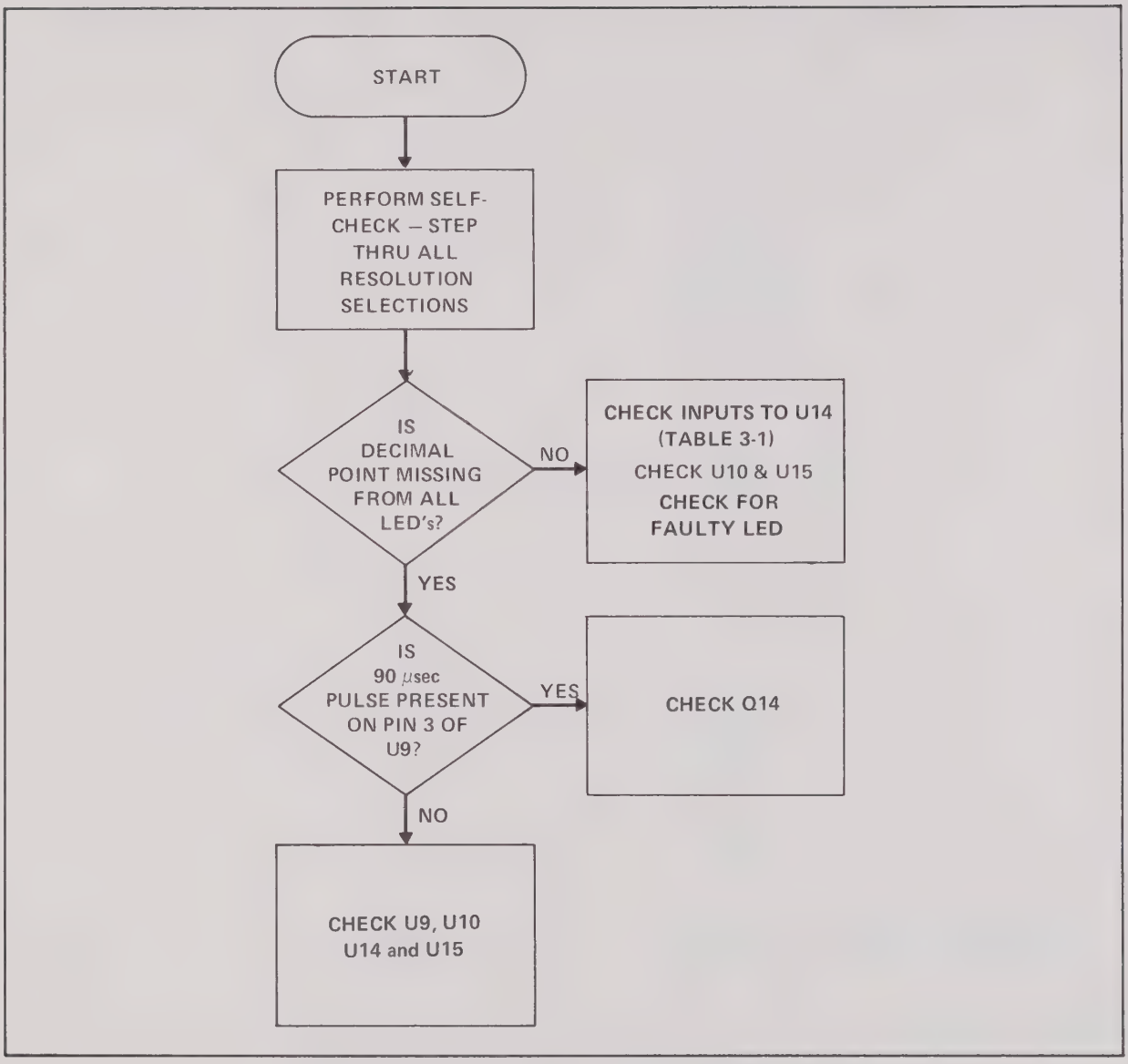
START
PERFORM SELF-CHECK – STEP THRU ALL RESOLUTION SELECTIONS
IS DECIMAL POINT MISSING FROM ALL LED's?
NO
CHECK INPUTS TO U14 (TABLE 3-1)
CHECK U10 & U15
CHECK FOR FAULTY LED
YES
IS 90 μsec PULSE PRESENT ON PIN 3 OF U9?
YES
CHECK Q14
NO
CHECK U9, U10 U14 and U15

Figure 4-6. FAULT ISOLATION – DECIMAL POINT MISSING

Section 5
Lists of Replaceable Parts

TABLE OF CONTENTS

ASSEMBLY NOMENCLATURE	PART NO.	PAGE
Final Assembly	1900A	5-3
Main PCB Assembly, Line Configuration	385021	5-5
Main PCB Assembly, Battery Configuration	378083	5-9
Input PCB Assembly	378125	5-13
Display PCB Assembly	378109	5-16
Inverter PCB Assembly	388447	5-18
DOU PCB Assembly	388470	5-20

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. Components are listed alphanumerically by assembly. Electrical components are listed by item number. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

a. Reference Designation or Item Number.

b. Description of each part.

c. Fluke Stock Number.

d. Federal Supply Code for Manufacturers. (See Appendix A for Code-to-Name list.)

e. Manufacturer's Part Number or Type.

f. Total Quantity per assembly or component.

g. Recommended Quantity: This entry indicates the recommending number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one in each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument, or are deviations from the basic instrument mode, the REC QTY column lists the recommended quantity of the item in that particular assembly.

h. Use Code is provided to identify certain parts that have been added, deleted or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity, paragraph 5-7.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6. To ensure the prompt and efficient handling of your order, include the following information:

a. Quantity.

b. FLUKE Stock Number.

c. Description.

d. Reference Designation or Item Number.

e. Printed Circuit Board Part Number.

f. Instrument Model and Serial number.

5-7. USE CODE EFFECTIVITY LIST

USE CODE	SERIAL NUMBER EFFECTIVITY
A.	0455000 and on

CAUTION!

Indicates devices are subject to damage by static discharge.

Table 5-1 FINAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	FINAL ASSEMBLY Figure 5-1		1900A				
1	Main PCB Assembly, Line						
1	Main PCB Assembly, Battery						
	Input PCB Assembly	378406	89536	378406	1		
2	Display PCB Assembly	378398	89536	378398	1		
3	Inverter PCB Assembly	388454	89536	388454	1		
4	Dou PCB Assembly [1]	388470	89536	388470	1		
5	Case, Molded Plastic	330076	89536	330076	1		
5	Case, Molded Plastic [1]	384800	89536	384800	1		
6	Handle, Molded Plastic	330092	89536	330092	1		
7	Front, Panel	378067	89536	378067	1		
8	Pad, Foot	338632	89536	338632	2		
9	Decal, Knob	347401	89536	347401	2		
10	Washer, Flat	340505	89536	340505	2		
11	Socket, I.C. [1]	276535	91506	316-AG39D	1		
	Line Cord	343723	89536	343723	1		
	Retainer, Neoprene	352484	77969	9109E	2		
	Coax Cable Assy.	395103	89536	395103	1		
	Receptacle, BNC	152033	95712	30355-1	1		
	Lens	384701	89536	384701	1		
	Front Decal	381434	89536	381434	1		
	Solder Lug	441972	79963	761	1		
[1]	-02 Dou Option						

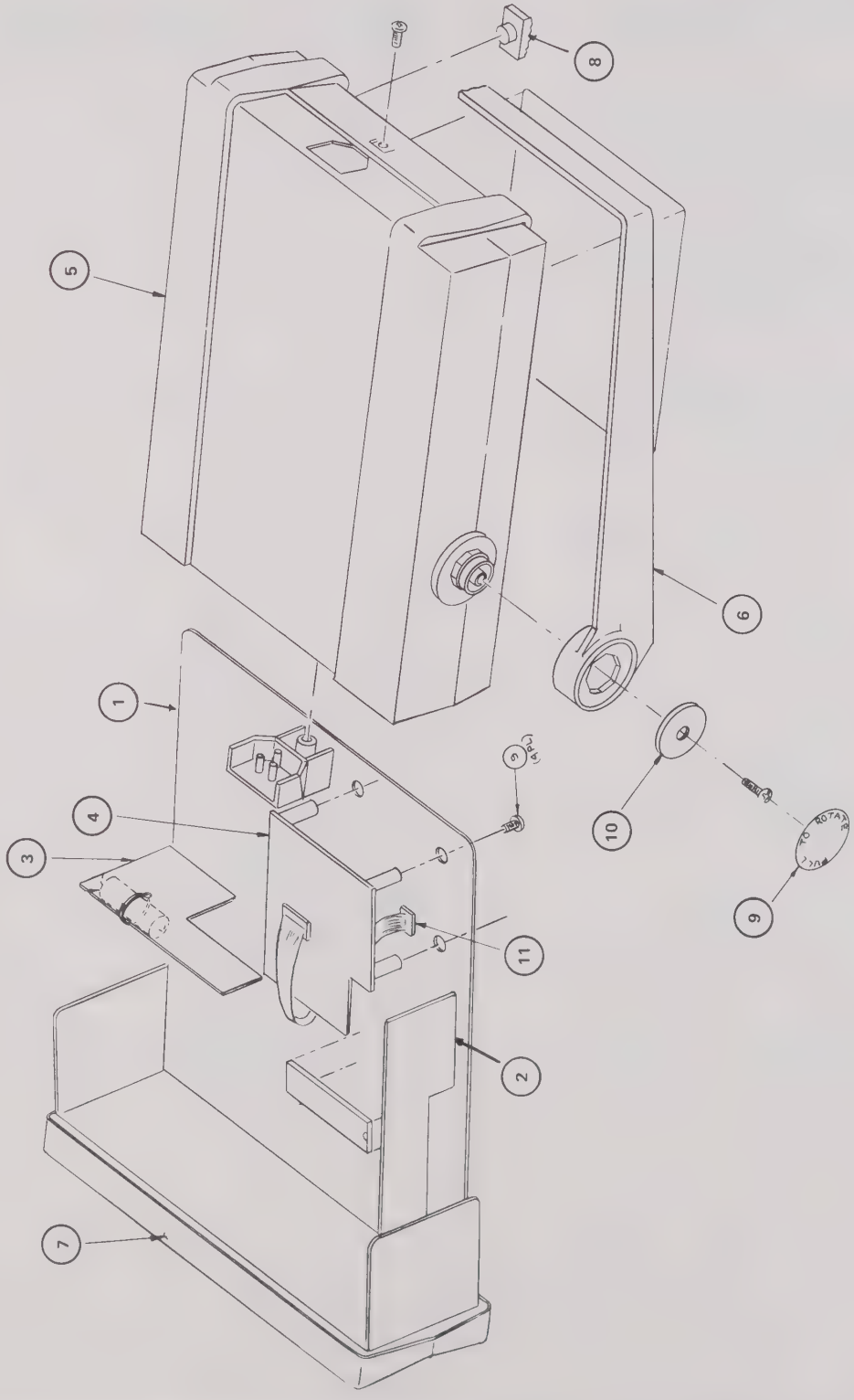

Figure 5-1. FINAL ASSEMBLY

Table 5-2 MAIN PCB ASSEMBLY, LINE

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	MAIN PCB ASSEMBLY, LINE Figure 5-2						
C1, C2, C4, C7, C12, C17	Cap, cer, 0.01 μF -20/+80%, 25V	335786	72982	5835-000-Y5U-103Z	6		
C3	Cap, cer, 0.1 μF ± GMV, 25V	369199	71590	UK-25-104	1		
C8, 18, 21	Cap, cer, 0.001 μF ±10%, 500V	357806	56289	C106B102G102K	3		
C9	Cap, cer, 47 pF ±20%, 1000V	369132	56289	C030B102H470J	1		
C10	Cap, cer, 22 pF ±20%, 500V	369157	72982	831-000-C0G0-220	1		
C11	Cap, var, 2 - 22 pF, 100V	369207	73445	C010KA/20E	1		
C13	Cap, Cer, 10 pF ±10%, 3 kV	105536	56289	40C362A1	1		
C14	Cap, elect, 470 μF -10/+50%, 40V	185868	73445	ET471X040A02	1	1	
C15	Cap, elect, 5000 μF -10/+100%, 10V	340893	99372	39C10HJ53	1	1	
C16	Cap, elect, 470 μF -10/+50%, 25V	168153	73445	ET471X025A01	1	1	
C19	Cap, cer, 100 pF ±10%, 1 kV	105593	71590	DD-101	1		
CR1, CR2, CR10, CR11	Diode, Hi-speed switching	203323	07910	1N4448	4	1	
CR3	Diode, zener	203547	07910	1N759A	1	1	
CR6, CR7, CR12	Diode, Si, Rect.	343491	04713	1N4002	3	1	
Q1 thru Q7	Xstr, Si, PNP	352369	12040	2N4403	7	2	
Q8 thru Q13, Q15	Xstr, Si, NPN	218396	04713	2N3904	7	2	
Q14	Xstr, Si, NPN	381798	04713	MPSA-13	1	1	
Q16	Xstr FET N-channel	386094	01295	SX3819	1	1	
R1	Res, comp, 5.6k ±5%, 1/4W	148080	01121	CB5625	1		
R2, R4	Res, comp, 470k ±5%, 1/4W	188441	01121	CB4745	2		
R3	Res, comp, 680k ±5%, 1/4W	188433	01121	CB6845	1		
R5, R9	Res, comp, 470 ±5%, 1/4W	147983	01121	CB4715	2		
R6	Res, comp, 2.7k ±5%, 1/4W	170720	01121	CB2725	1		

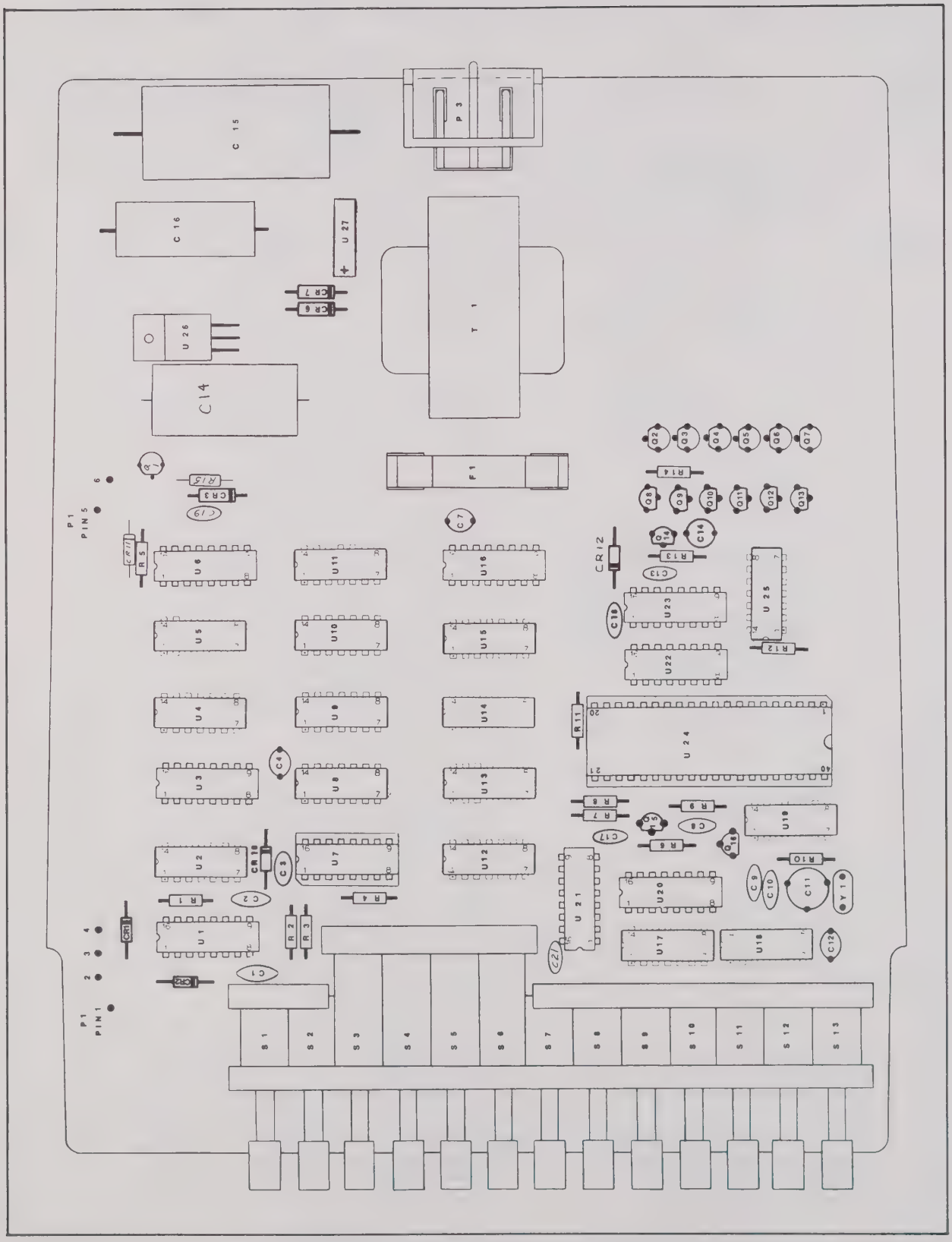

Figure 5-2. MAIN PCB ASSEMBLY – LINE CONFIGURATION

Table 5-2 MAIN PCB ASSEMBLY, LINE (cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R7, R15	Res, comp, 10k ±5%, 1/4W	148106	01121	CB1035	2		
R8	Res, comp, 56 ±5%, 1/4W	147900	01121	CB5605	1		
R10	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	1		
R11	Res, comp, 27k ±5%, 1/4W	148148	01121	CB2735	1		
R12	Res, comp, 10 ±5%, 1/4W	147868	01121	CB1005	1		
R13	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	1		
R14	Res, comp, 120 ±5%, 1/4W	170712	01121	CB1215	1		
S1 thru S13	Switch Assembly	386078	89536	386078	1		
T1	Xfmr, 115/230	433102	89536	433102	1		
T1	Xfmr, 100V	433094	89536	433094	1		
U1, U6, U16	IC, Dig, C-MOS, hex buffer/inverter ⊗	381848	18725	CD4049AE	3	1	
U2, U12	IC, Dig, TTL, MSI decade counters	293159	01295	SN7490N	2	1	
U3	IC, TTL, BCD to decimal decoders	293142	01295	SN7442N	1	1	
U4, U13, U14	IC, C-MOS, dual, type "D" flip-flop ⊗	340117	04713	MC14013CP	3	1	
U5, U18	IC, Dig, C-MOS, quad, 2-input, NAND gates ⊗	355198	18725	CD4011CP	2	1	
U7	IC, MOS, counter, timer base circuit ⊗	381822	50088	MK5009P	1	1	
U8	IC, TTL, dual, d-type edge triggered flip-flops	310227	01295	SN7474N	1	1	
U9	IC, Dig, C-MOS, 4-input, POS NAND gates ⊗	355206	04713	MC14012CP	1	1	
U10, U15	IC, Dig, C-MOS, triple, 3-input, NAND gates ⊗	375147	18725	CD4023AE	2	1	
U11	IC, Dig, COS/MOS, quad, 2-input, NOR gates ⊗	355172	18725	CD4001AE	1	1	
U17	IC, Dig, TTL, quad, 2-input, pos, NAND gates	293068	01295	SN74H00N	1	1	
U19	IC, Dig, TTL, 30 MHz, presettable decade	393256	01295	SN74LS196N	1	1	
U20, U21	IC, TTL, dual, j-k edge triggered flip-flop	363440	01295	SN74S112N	2	1	
U22	IC, Dig, C-MOS, hex buffer/inverters ⊗	381830	18725	CD4050AE	1	1	
U23	IC, TTL, BCD-TO-SEVEN seg, decoder/ driver (selected)	385872	01295	SN7447AN	1	1	

Table 5-2 MAIN PCB ASSEMBLY, LINE (cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U24	IC, Dig, MOS, 7 digit 2.5 MHz decimal counter	380238	55261	1801A	1	1	
U25	Res, network	412866	89536	412866	1	1	
U26	IC, linear, POS VOL REG	381814	07623	78M05U0C	1	1	
U27	Rectifier Bridge	296509	51605	KBP-02	1	1	
Y1	Crystal Quartz	385732	11068	183025B	1		
F1	Fuse, fast acting 1/4 amp	109314	71400	AGC1-4	1		
	Contact, voltage	338657	89536	338657	2		
	Contact, earth common	448910	89536	448910	1		
	Insulator, contact	344184	89536	344184	1		
	Strap, rubber, mousetail	104794	98159	2829-115-3	1		
	Insulator, recptacle	338624	89536	338624	1		
	Connector Pin	376574	00779	3-87022-1	8		
	Socket, I.C. 16 pin	370312	91506	316-AG39D	1		
	Socket, I.C. 40 pin	386060	09922	DILB40P1	1		
	Fuse Clip	284984	84613	3621-2	1		
	Pushbutton, putty grey	369546	71590	J52305-T31753	12		
	Pushbutton, green	352211	71590	J52305-J71449	1		

Table 5-3 MAIN PCB ASSEMBLY, BATTERY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	MAIN PCB ASSEMBLY, BATTERY Figure 5-3	385021	89536	385021	REF		
BT1 thru BT4	Battery, Nicad, Rechargeable	346924	06001	41B004AD15	4		
C1, C2, C4, C7, C12, C17	Cap, cer, 10,000 pF -20/+80%, 25V	335786	72982	5835-000-Y5U-103Z	6		
C3	Cap, cer, 0.1 μF $\pm$ GMV, 50V	369199	71590	UK-25-104	1		
C5	Cap, ta, 22 μF $\pm$20%, 25V	357780	56289	196D226X0025-PE4	1		
C8, C18, C21	Cap, cer, 100 pF $\pm$10%, 500V	357806	56289	C106B102G102K	3		
C9	Cap, cer, 47 pF $\pm$20%, 1000V	369132	56289	C030B102H470J	1		
C10	Cap, cer, 22 pF $\pm$20%, 500V	369157	72982	831-000-C0G0-220	1		
C11	Cap, var, polyprop, 2-22	369207	73445	C010KA/20E	1	1	
C13	Cap, cer, 10 pF $\pm$10%, 3 kV	105536	56289	40C362A1	1		
C19	Cap, cer, 100 pF $\pm$10%, 1 kV	105593	71590	DD-101	1		
CR1, CR2, CR10, CR11	Diode, Hi-speed, switching	203323	07910	1N4448	4	1	
CR3	Diode, zener, uncomp	203547	07910	1N759A	1	1	
CR4, CR5, CR12	Diode, Si, Rect	343491	04713	1N4002	3	1	
Q1 thru Q7	Xstr, Si, PNP	352369	12040	2N4403	7	2	
Q8 thru Q13, Q15	Xstr, Si, NPN	218396	04713	2N3904	7	2	
Q14	Xstr, Si, NPN	381798	04713	MPSA-13	1	1	
Q16	Xstr, FED, N-channel, Junction	386094	01295	SX3819	1	1	
R1	Res, comp, 5.6k $\pm$5%, 1/4W	148080	01121	CB5625	1		
R2, R4	Res, comp, 470k $\pm$5%, 1/4W	188441	01121	CB4745	2		
R3	Res, comp, 680k $\pm$5%, 1/4W	188433	01121	CB6845	1		
R5, R9	Res, comp, 470 $\pm$5%, 1/4W	147983	01121	CB4715	2		
R6	Res, comp 2.7k $\pm$5%, 1/4W	170720	01121	CB2725	1		

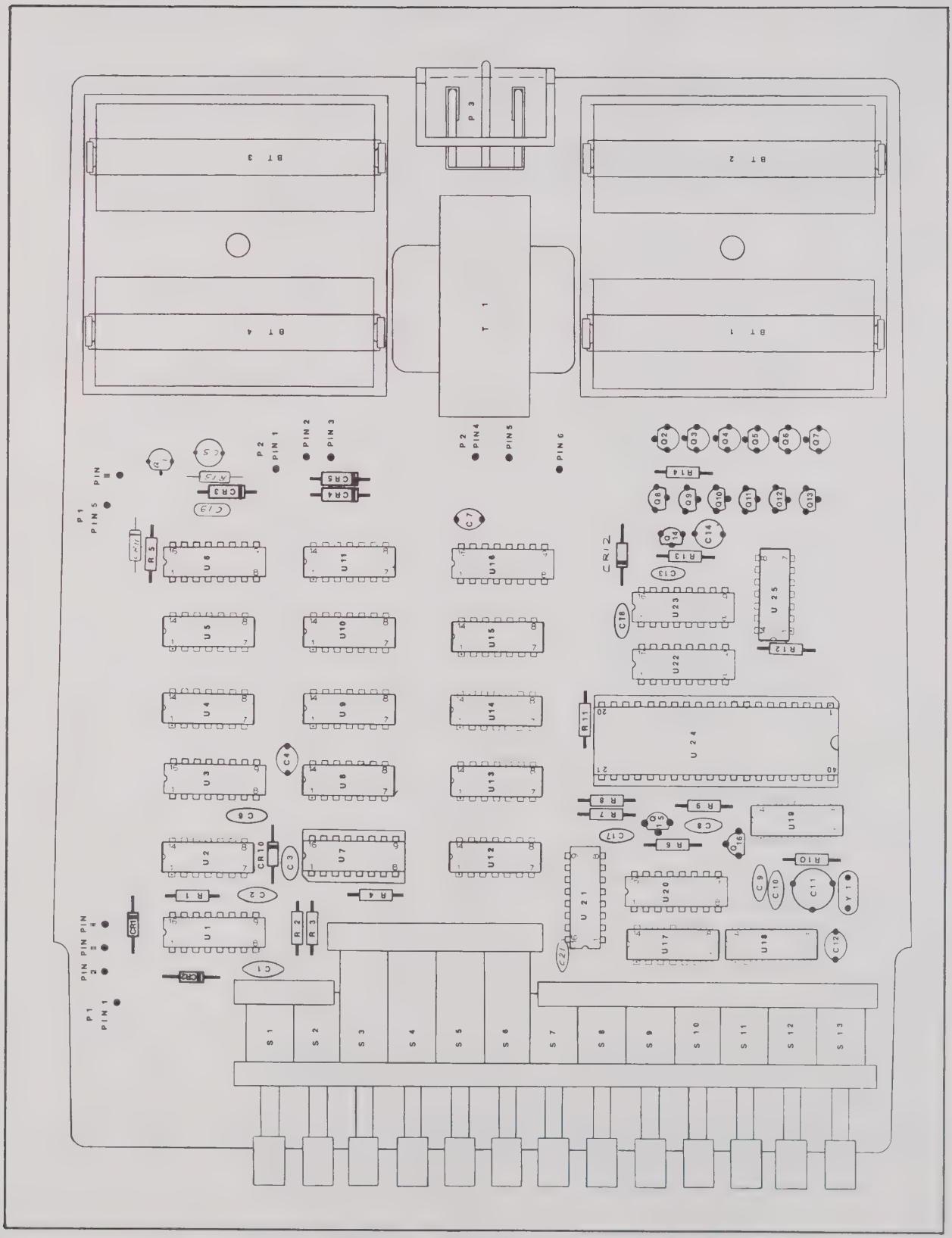

Figure 5-3. MAIN PCB ASSEMBLY – BATTERY (–01 OPTION) CONFIGURATION

Table 5-3 MAIN PCB, BATTERY (cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R7, R15	Res, comp, 10k ±5%, 1/4W	148106	01121	CB1035	2		
R8	Res, comp, 56 ±5%, 1/4W	147900	01121	CB5605	1		
R10	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	1		
R11	Res, comp, 27k ±5%, 1/4W	148148	01121	CB2735	1		
R12	Res, comp, 15 ±5%, 1/4W	147876	01121	CB1505	1		
R13	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	1		
R14	Res, comp, 120 ±5%, 1/4W	170712	01121	CB1215	1		
S1 thru S13	Switch Assy	386078	89536	386078	1		
T1	Xfmr, battery	433110	89536	433110	1		
U1, 6, 16	IC, Dig, C-MOS, hex buffer/inverters ⊗	381848	18725	CD4049AE	3	1	
U2, 12	IC, Dig, TTL, MSI, decade counters	402545	01295	SN74LS90N	2	1	A
U3	IC, Dig, 4-line to 10 line decoder, BCD to decimal	408716	01295	SN74LS42N	1	1	A
U4, U13, U14	IC, C-MOS, dual, type "D" flip-flop ⊗	340117	04713	MC14013CP	3	1	
U5, U18	IC, Dig, C-MOS, quad, 2-input, NAND gates ⊗	355198	04713	MC14011CP	2	1	
U7	IC, MOS, counter, time base circuit ⊗	381822	50088	MK5009P	1	1	
U8	IC, Dig, TTL, dual D with clear and preset	393124	01295	SN74LS74N	1	1	A
U9	IC, Dig, C-MOS, dual 4-input, POS NAND gates ⊗	355206	04713	MC14012CP	1	1	
U10, U15	IC, Dig, C-MOS, triple 3-input NAND gates ⊗	375147	04713	MC14011CP	2	1	
U11	IC, Dig, COS/MOS, quad 2-input, NOR gates ⊗	355172	04713	MC14001CP	1	1	
U17	IC, Dig, TTL, quad, 2-input, POS NAND gates	393033	01295	SN74LS00N	1	1	A
U19	IC, Dig, TTL, 30 MHz prestbl decade or binary cntr/ltch	393256	01295	SN74LS196N	1	1	A
U20, U21	IC, TTL, dual J-K, edge triggered flip-flop	363440	01295	SN74LS112N	2	1	A
U22	IC, Dig, C-MOS, hex buffer, inverters ⊗	381830	18725	CD4050AE	1	1	
U23	IC, TTL, selected, BCD to 7-seg decoder/ driver	385872	01295	SN7447AN	1	1	
U24	IC, Dig, MOS, 7 digit 2.5 MHz decimal counter ⊗	380238	55261	1801A	1	1	

Table 5-3 MAIN PCB, BATTERY (cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U25	Res, network	417147	89536	417147	1	1	
Y1	Crystal, quartz	385732	11068	183025B	1		
	Battery Holder	390450	89536	390450	4		
	Battery Contact	344200	89536	344200	4		
	Conn, pin	376574	00779	3-87022-1	8		
	Contact, earth common	448910	89536	448910	1		
	Contact, voltage	338657	89536	338657	2		
	Insulator, recpt	338624	89536	338624	1		
	Pushbutton, puttygrey	369546	71590	J52305-T31753	12		
	Pushbutton, green	352211	71590	J52305-J71449	1		
	Socket, IC, 16-pin	370312	91506	316-AG39D	1		
	Socket, IC, 40-pin	386060	09922	D1LB40P1	1		

Table 5-4 INPUT PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	INPUT PCB ASSEMBLY Figure 5-4	378406	89536	378406	REF		
	Input PCB 1900A-3003	378117	89536	378117			
C1	Cap, poly, est, 0.10 μF ±20%, 250V	441345	73445	C281A/A100K	1		
C2	Cap, cer, 100 pF ±10%, 1 kV	105593	71590	DD-101	1		
C3, C8 C13	Cap, cer, 0.01 μF +8-/-20%, 25V	335786	32897	5835-000Y5U-103Z	4		
C4, C5	Cap, Ta, 22 μF ±20%, 25V	357780	56289	196D226X0025-PE4	2		
C6	Cap, cer, 0.0012 μF ±10%, 500V	106732	71590	CF-102	1		
C7, C11, C12	Cap, Ta, 10 μF ±20%, 15V	193623	56289	196D106X0015-KA1	3		
C9	Cap, mini cer, 4.7 pF ± 0.25 pF, 100V	362772	72982	8101-A100-C0G-479G	1		
C10	Cap, cer, 47 pF ±20%, 1000V	369132	56289	C030B102H470J	1		
CR1, CR2, CR3, CR4	Diode, Ultra fast, lo cap, Si	381806	07263	1N3062	4	1	
CR5, CR6, CR7, CR8	Diode, switching, hi-speed	203323	07910	1N4448	4	1	
CR9	Diode, zener	386771	07263	1N756A	1		
Q1	Xstr, FED, N-channel	288324	12040	SF50070	1		
Q2, Q3, Q5, Q6, Q7	Xstr, PNP, high speed switch	369629	07263	2N5771	5		
Q4	Xstr, NPN, Si, lo P	369645	07263	2N4274	1		
R1, R24	Res, comp, 180 ±5%, 1/4W	147942	01121	CB1815	2		
R2	Res, comp, 120k ±5%, 1/4W	193458	01121	CB1245	2		
R3	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	1		
R4, 5, 18, 19, 20, 22, 23, 26, 27	Res, comp 560 ±5%, 1/4W	147991	01121	CB5615	9		
R6, R11	Res, comp 1k ±5%, 1/4W	148023	01121	CB1025	2		
R7	Res, comp, 100 ±5%, 1/4W	147926	01121	CB1015	1		

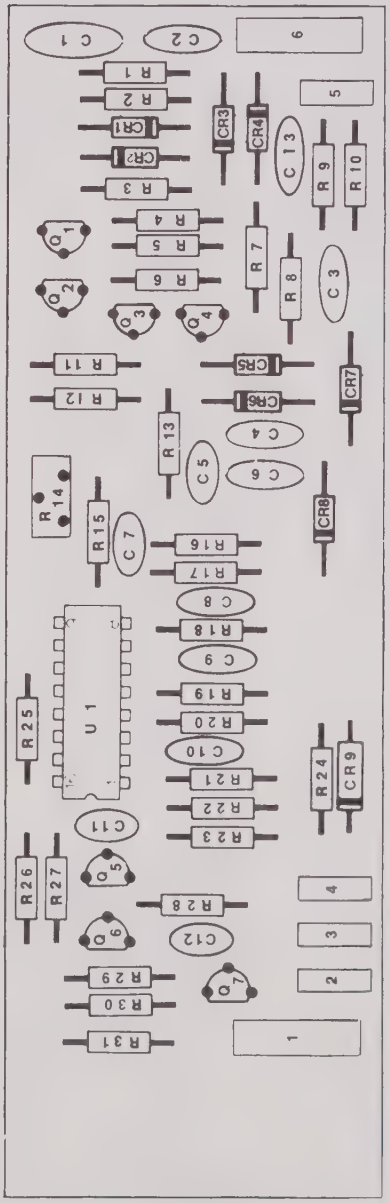

Figure 5-4. INPUT PCB ASSEMBLY

Table 5-4 INPUT PCB ASSEMBLY (cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R8	Res, comp, 10k ±5%, 1/4W	148106	01121	CB1035	1		
R9, R16, R17, R29	Res, comp, 3.3k ±5%, 1/4W	148056	01121	CB3325	4		
R10	Res, comp, 330 ±5%, 1/4W	147967	01121	CB3315	1		
R12	Res, comp, 10 ±5%, 1/4W	147868	01121	CB1005	1		
R13	Res, comp, 82 ±5 %, 1/4W	149484	01121	CB8205	1		
R14	Res, trimpot, 10k ±20%	385393	54869	PT10H(2.5)10K	1	1	
R15	Res, comp, 47k ±5%, 1/4W	148163	01121	CB4735	1		
R21	Res, comp, 680 ±5%, 1/4W	148007	01121	CB6815	1		
R25	Res, comp, 270 ±5%, 1/4W	160804	01121	CB2715	1		
R28	Res, comp, 33 ±5%, 1/4W	175034	01121	CB3305	1		
R30	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	1		
R31	Res, comp, 220 ±5%, 1/4W	147959	01121	CB2215	1		
U1	IC, ECL, tripple line recv, OR/NOR	369702	04713	MC10116L	1		
	Connector, test jack	149112	74970	105-0753	2		
	Amp connector	375329	00779	85863-3	4		

Table 5-5 DISPLAY PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	DISPLAY PCB ASSEMBLY **Figure 5-5**	378387	89536	378398	REF		
DS201, 202, 203	Diode Light Emitting	385898	28480	5082-4487	3		
U201, 202, 203, 204, 205, 206	Led, display	429985	50579	DL-707-811	6		

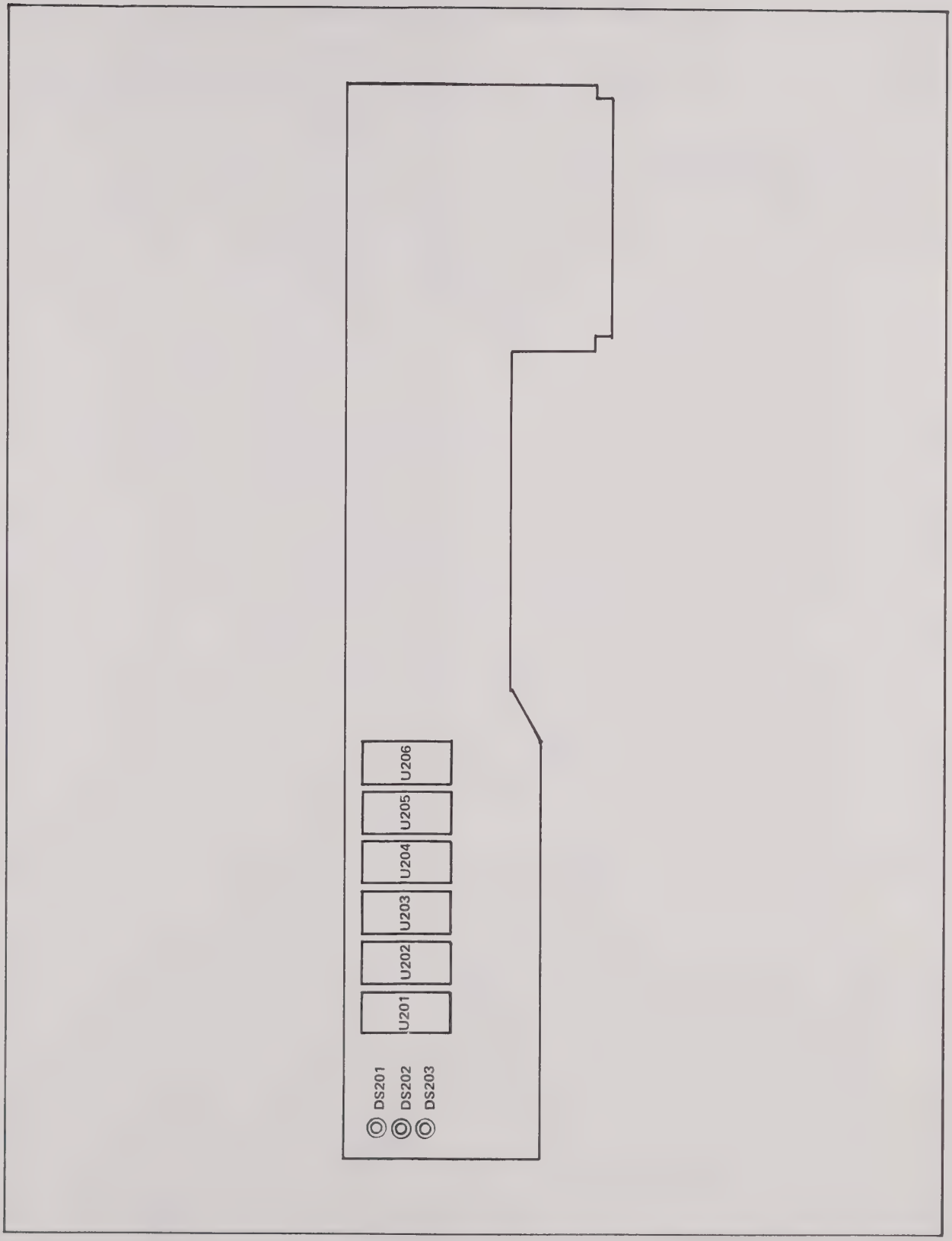

Figure 5-5. DISPLAY PCB ASSEMBLY

Table 5-6 INVERTER PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	INVERTER PCB ASSEMBLY Figure 5-6	388447	89536	388447	REF		
C401	Cap, mylar, 5 µF, ±5%, 200V [1]	106997	06739	D2-505D	1		
	Cap, mylar, 8 µF, ±5%, 200V [2]	380261	89536	380261	1		
	Cap, met, poly prpln, 2.8 µF, ±5%, 300V [3]	394197	89536	394197	1		
C402	Cap, fxd cer, 47 pF ±20%, 100V	369132	56289	C030B102H4705	1		
C403	Cap, Ta, 10 µF ±20%, 15V	193623	56289	196D106X0015-JA1	1		
C404	Cap, fxd cer, 0.1 µF, 25V	369199	71590	UK-25-104	1		
C405	Cap, elect, 10,000 µF, -10/+100%, 6V	387241	99392	39CS6J14	1		
CR401, 402	Diode, Hi-speed switching	203323	07910	1N4448	2	1	
CR403, 404	Diode, zener	291575	12969	UZ8720	2	1	
F1	Fuse, 1/2 amp, 250V	109322	71400	MDL	1	5	
L1	Coil	320911	89536	320911	1		
Q401, 402	Xstr, Si, NPN	218396	04713	2N3904	2	1	
R401	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	1		
R402	Res, comp, 22 ±5%, 1/4W	147884	01121	CB2205	1		
R403	Res, comp, 330 ±5%, 1/4W	147967	01121	CB3315	1		
R404	Res, comp, 82 ±5%, 1/4W	149484	01121	CB8205	1		
T2	Xfmr	417048	89536	417048	1		

[1] For 115V, 60 Hz versions

[2] For 100V, 50 Hz versions

[3] For 230V, 50 Hz versions

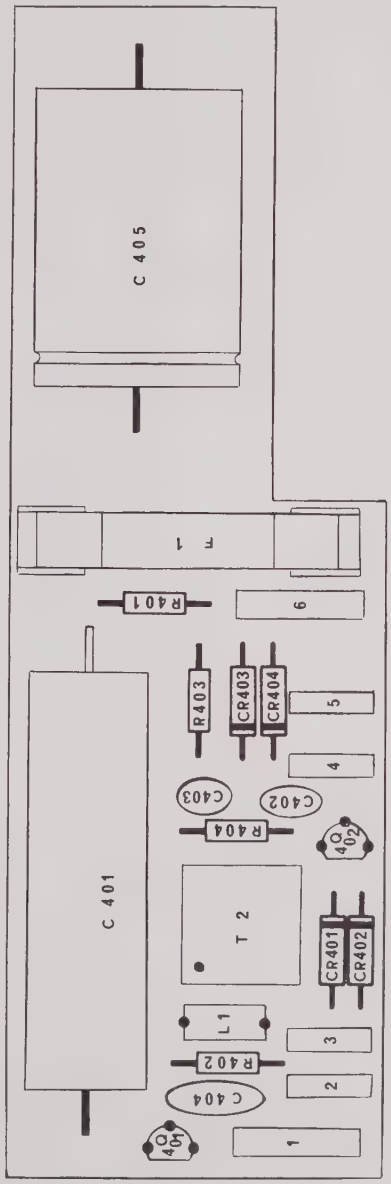

Figure 5-6. INVERTER PCB ASSEMBLY

Table 5-7 D.O.U. PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	DOU PCB ASSEMBLY **Figure 5-7**						
C1	Cap, Ta, 22 μF $\pm$20%, 25V	357780	56289	196D226X0025-PE4	1	1	
C2	Cap, cer, 68 pF $\pm$10%, 1 kV	106153	71590	DD680	1		
C3	Cap, cer 0.1 μF + GMV, 25V	369199	71590	UK-25-104	1		
R1	Res, comp, 47k $\pm$5%, 1/4W	148163	01121	CB4735	1		
R2	Res, comp, 100k $\pm$5%, 1/4W	148189	01121	CB1045	1		
U1, U3, U4	IC, C-MOS, NAND gates	355198	04713	MC14011CP	3		
U2	IC, C-MOS, dual multivibrator	393512	04713	MC14528CD	1		
U5, U7 thru U12	IC, C-MOS, quad clocked d latch	355149	18725	CD4042AE	7		
U6	IC, C-MOS, bcd-to-decimal decoder	380741	18725	CD4028AE	1		
	Spacer, hex	394528	89536	394528	4		
	Flat Cable Assy	393520	52072	CAD16P-02-261-TT-006	1		

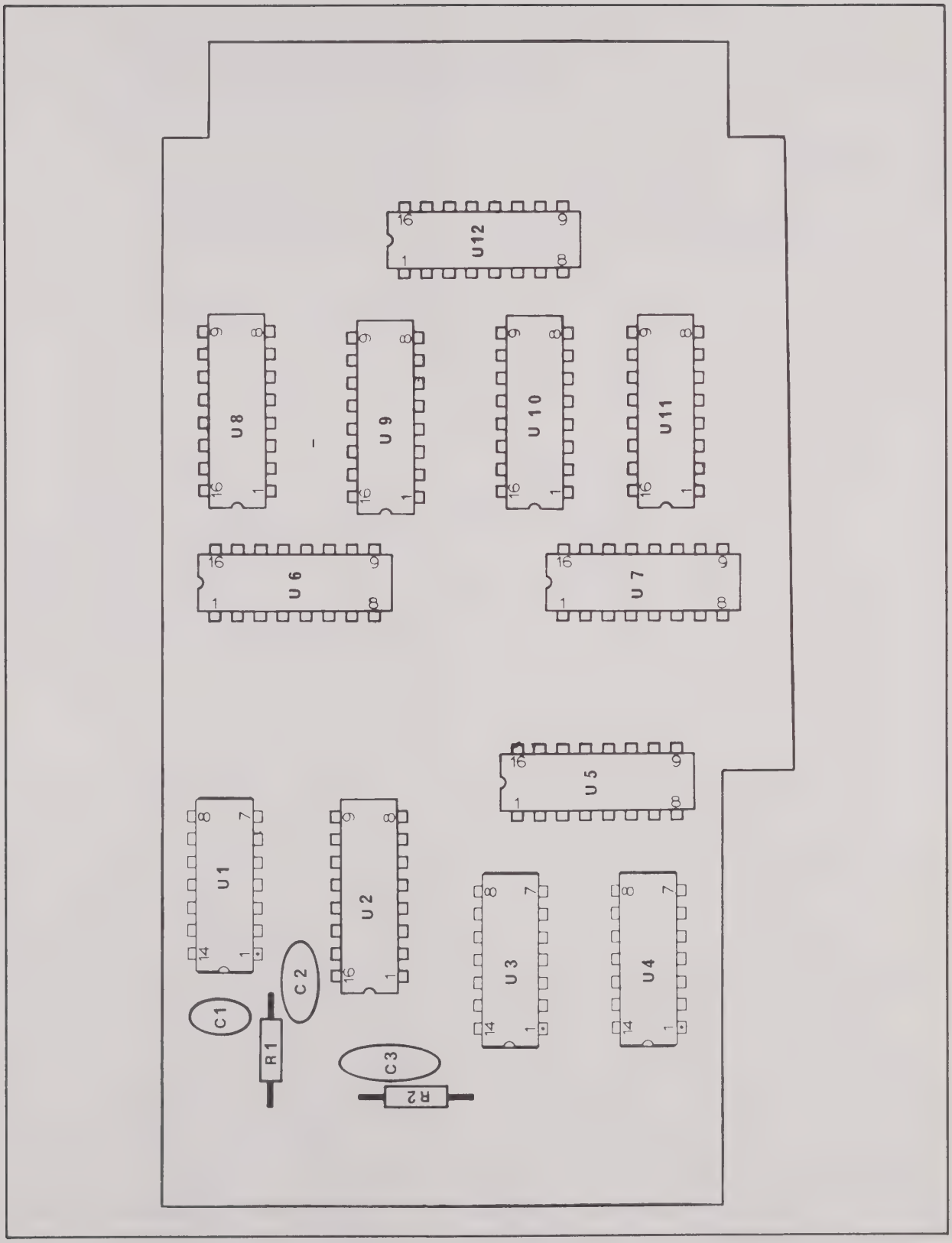

Figure 5-7. D.O.U. PCB ASSEMBLY

Section 6
Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual contains information pertaining to the options and accessories available for your instrument. Each option and accessory is described under a separate major heading containing the model or option number. The option descriptions contain applicable operating and maintenance instructions, and field installation procedures. A list of replaceable parts and the schematics are located in Sections 5 and 8 respectively.

6-3. BATTERY PACK, OPTION –01

WARNING

Damage may result if alkaline, zinc-carbon, or mercury batteries are charged in the 1900A.

6-4. Power for the Model 1900A-01 is supplied by internal rechargeable batteries that allow the instrument to operate for at least four hours. The batteries should be recharged after every four hours of operation or when the input sensitivity falls below specifications. Recharging is most rapidly accomplished by switching the 1900A power switch to the OFF position and connecting the instrument to ac line power. In this way, the discharged batteries can be completely recharged in approximately 12 to 14 hours. The instrument can also be operated when recharging the batteries, but the recharging time will be extended to approximately 56 hours. Batteries should be recharged within the temperature limits of 15°C to 23°C. Exceeding these limits will reduce storage capacity and may reduce battery life.

NOTE

Battery manufacturers recommend that nickel cadmium batteries not be stored for extended periods of time without recharging at least every 90 days. Storage temperature below 25°C are recommended.

6-5. Battery Replacement

6-6. The procedure described below provides step-by-step instructions for replacing the batteries in the Model 1900A-01.

CAUTION

Do not remove the batteries before disconnecting the instrument from input line power.

a. Disconnect line power cord. Remove retainer screw from rear of instrument case, and remove instrument from case.

b. On the underside of PCB, remove two threaded bolts securing battery holders in place.

c. Remove holder tops and batteries.

d. Replace batteries with 1.2 volt nickel-cadmium batteries (JF part no. 346924). Install the batteries adhering to polarity indications on battery holder.

NOTE

Use 1.2 volt nickel-cadmium batteries only.

6-7. Battery Powered Instrument Repair Techniques

6-8. In battery-powered instruments, one of the batteries should be removed before attempting any repairs. This is necessary to eliminate the danger of shorting portions of the circuitry which carry the battery voltage. Remove the batteries as described under Battery Replacement.

6-9. DATA OUTPUT UNIT, OPTION –02

6-10. Introduction

6-11. The Fluke Model 1900A counter, when equipped with a Data Output Unit is compatible with data logging systems which accept parallel bits of information in binary coded decimal (1, 2, 4, 8) format. The data available from the counter contains digit, overflow, decimal point, units, and print command information. The drive capability of all data outputs in CMOS compatible; able to sink .16mA at logic 0 or source .16mA for logic 1 levels.

6-12. Operation

6-13. OUTPUT DATA

6-14. The output data available at the rear-panel D.O.U. connector is listed in Table 6-1. The pin functions and decimal point code are provided.

6-15. D.O.U. 44 PIN CONNECTOR KIT

6-16. A 50 pin connector kit is provided to allow custom fabrication of an interface cable. The kit (JF part no. 410241) consists of the following items:

ITEM	DESCRIPTION	QUANTITY	FLUKE P/N
1	Connector, 50 pin	1	407320
2	Connector Backshell	2	398008
3	AMP pins	38	394569
4	Polarizing Key	1	386169
5	Form	1	433425

The interconnecting cable (telephone type D-50) and the termination connector for making the custom interface cable are customer supplied. The 50-conductor, telephone type D-50 cable (Fluke P/N 320317) can be ordered from the John Fluke Mfg. Co.; when doing so indicate how many feet are required.

Table 6-1. DATA OUTPUT UNIT (D.O.U.) CONNECTIONS

PIN NO.	FUNCTION	PIN NO.	FUNCTION
1	–	A	Ground
2	Print Command	B	–
3	–	C	–
4	–	D	–
5	–	E	–
6	Overflow	F	Decimal Point (L)
7	Decimal Point (M)	H	Decimal Point (N)
8	LSD – BCD 8	J	LSD – BCD 4
9	LSD – BCD 2	K	LSD – BCD 1
10	5SD – BCD 8	L	5SD – BCD 4
11	5SD – BCD 2	M	5SD – BCD 1
12	4SD – BCD 8	N	5SD – BCD 4
13	4SD – BCD 2	P	4SD – BCD 1
14	3SD – BCD 8	R	3SD – BCD 4
15	3SD – BCD 2	S	3SD – BCD 1
16	2SD – BCD 8	T	2SD – BCD 4
17	2SD – BCD 2	U	2SD – BCD 1
18	MSD – BCD 8	V	MSD – BCD 4
19	MSD – BCD 2	W	MSD – BCD 1
20	MHz	X	μS
21	kHz	Y	mS
22	Hz	Z	Dimensionless *

*Goes high in TOTALIZE function.

DECIMAL POINT POSITION CODING

(L) Pin F	(M) Pin 7	(N) Pin H	DECIMAL POINT POSITION
0	0	0	XX.XXXX
1	0	0	XXX.XXX
1	0	1	XXXX.XX
0	0	0	– – –

6-17. Theory of Operation

6-18. The D.O.U. consists of a series of latches which, when enabled, store the digit, decimal, and unit information. The stored data is updated at each 1900A gate time. The memory update command (MUP), used to update the data stored in the latches in U24, also generates the trigger at pin 2 of the DOU connector. The trigger (1ms positive pulse) indicates that new data is being loaded; the D.O.U. output data should be ignored during this time.

6-19. The display data is applied to the D.O.U. in bcd format (1, 2, 4, 8) on J3 pins 1, 16, 10 and 9 respectively (see Data Output Unit Schematic, Section 8). The bcd equivalent of each digit of the display, least significant (LSD) through the most significant (MSD), is strobed on to the four lines for 90 ms each. The strobe signal that applies each significant digit to the four data lines also enables a latch in the D.O.U. which corresponds to the significant digit information on the four data lines. The decimal point code (L, M, N) is produced by nand gates using the decimal strobe (DS) along with digit strobe AS2, AS3, or AS4.

Section 7

General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

D9816
Westermann Wilhelm Augusta-Anlage
Mannheim-Nackarau Germany

S0482
Sony Corp.
Tokyo, Japan

S3774
Oshino Electric Lamp Works
Tokoyo, Japan

0AD86
IN General
El Paso, TX

0AE89
Autosplice Inc.
Woodside, NY

0BW21
Noritake Co. Inc.
Burlington, MA

0ANF0
Topaz Semiconductor Inc
San Jose, CA

0DSM7
Conductive (Pkg) Containers Inc.
Brookfield, WI

0CLN7
Emhart Fastening Group
Shelton, CT

0FB81
S-Mos Systems Inc.
San Jose, CA

0FFP1
Eveready LTD
Ever Ready Special Battery Div.
Dawley Telford Salop UK

00199
Marcon Electronics Corp
Keamy, NJ

00213
Nytronics Comp. Group Inc.
Darrlington, NC

00327
Welwyn International Inc.
Westlake, OH

00656
Aerovox Corp.
New Bedford, MA

00686
Film Capacitors Inc.
Passaic, NJ

00779
AMP, Inc.
Harrisburg, Pennsylvania

00853
Sangamo Weston Inc
Components Div
Pickens, NC

01091
Allied Plastics Co.
Los Angeles, CA

01101
Wabash Inc
(Formerly Wabash Magnetics)
Wabash, IN

01121
Allen Bradley Co.
Milwaukee, WI

01281
TRW Electronics & Defense Sector
R F Devices
Lawndale, CA

01295
TX Instruments Inc.
Semiconductor Group
Dallas, TX

01526
Genicom
Waynesboro, VA

01537
Motorola Communications &
Electronics Inc.
Franklin Park, IL

01686
RCL Electronics/Shallcross Inc.
Electro Components Div.
Manchester, NH

01884
Sprague Electric Co.
(Now 56289)

01961
Varian Associates Inc.
Pulse Engineering Div.
Convoy, CT

01963
Cherry Electrical Products Corp
Waukegan, IL

02111
Spectrol Electronics Corp.
City of Industry, CA

02114
Amperex Electronic Corp.
Ferrox Cube Div.
Saugerties, NY

02131
General Instrument Corp.
Government Systems Div.
Westwood, MA

02395
Sonar Radio Corp.
Hollywood, FL

02533
Leigh Instruments Ltd.
Frequency Control Div.
Don Mills, Ontario, Canada

02606
Fenwal Labs
Division of Travenal Labs
Morton Grove, IL

02660
Bunker Ramo-Eltra Corp.
Amphenol NA Div.
Broadview, IL

02697
Parker-Hannifin Corp.
O-Ring Div
Lexington, KY

02735
RCA-Solid State Div.
Somerville, NJ

02768
ITW (IL Tool Works)
Fastex Division
Des Plaines, IL

02799
Arco Electronics Inc.
Chatsworth, CA

03296
Nylon Molding Corp.
Monrovia, CA

03445
Lercon Electronics Inc
Burbank, CA

03508
General Electric Co.
Semiconductor Products
& Batteries
Auburn, NY

03797
Genisco Technology Corp.
Eltronics Div.
Rancho Dominquez, CA

03877
Gilbert Engineering Co.Inc
Incon Sub of Transitron
Electronic Corp.
Glendale, AZ

03888
KDI Electronics Inc.
Pyrofilm Div.
Whippany, NJ

03911
Clairex Corp.
Clairex Electronics Div.
Mount Vernon, NY

03980
Muirhead Inc.
Mountainside, NJ

04009
Cooper Industries, Inc.
Arrow Hart Div.
Hartford, CT

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, CA

04221
Midland-Ross Corp.
Midtex Div.
N. Mankato, MN

04222
AVX Corp.
AVX Ceramics Div.
Myrtle Beach, SC

04423
Telonic Berkley Inc.
Laguna Beach, CA

04713
Motorola Inc.
Semiconductor Group
Phoenix, AZ

04946
Standard Wire and Cable
Rancho Dominquez, CA

05173
General Radio
NY,NY.
Replaced by:

24655
Genrad,INC.
Concord, MA

05236
Jonathan Mfg. Co.
Fullerton, CA

05245
Corcom Inc.
Libertyville, IL

05276
ITT Pomona
Electronics Div.
Pomona, CA

05277
Westinghouse Elec. Corp.
Semiconductor Div.
Youngwood, PA

05347
Ultronix Inc
Grand Junction, CO

05397
Union Carbide Corp.
Materials Systems Div.
Cleveland. OH

05571
Sprague Electric Co.
(Now 56289)

05574
Viking Connectors Inc
Sub of Criton Corp.
Chatsworth, CA

05791
LYN-TRON
Burbank, CA

05820
EG & G Wakefield Engineering
Wakefield, MA

05839
Advance Electrical
Chicago, IL

05972
Loctite Corp.
Newington, CT

06001
General Electric Co.
Electric Capacitor Product Section
Columbia, SC

06141
Fairchild Weston Systems Inc.
Data Systems Div.
Sarasota, FL

06192
La Deau Mfg. Co.
Glendale, CA

06229
Electrovert Inc.
Elmsford, NY

06383
Panduit Corp.
Tinley Park, IL

06473
Bunker Ramo Corp.
Amphenol NA Div.
SAMS Operation
Chatsworth, CA

06540
Mite Corp
Amatom-Electrical Div

06555
Beede Electrical Instrument
Penacook, NH

06665
Precision Monolithics
Sub of Boums Inc.
Santa Clara, CA

06666
General Devices Co. Inc.
INpolis, IN

06739
Electron Corp.
Littleton, CO

06743
Gould Inc.
Foil Div.
Eastlake, OH

06751
Components Inc.
Semcor Div.
Phoenix, AZ

06776
Robinson Nugent Inc.
New Albany, IN

06915
Richco Plastic Co.
Chicago, IL

06961
Vemitron Corp.
Piezo Electric Div.
Bedford, OH

06980
ELMAC
(See Varian)
San Carlos, CA

07047
Ross Milton Co., The
Southampton, PA

07138
Westinghouse Electric Corp.
Industrial & Government
Tube Div.
Horseheads, NY

07233
Benchmark Technology Inc.
City of Industry, CA

07239
Biddle Instruments
Blue Bell, PA

07256
Silicon Transistor Corp.
Sub of BBF Inc.
Chelmsford, MA

07261
Avnet Corp.
Culver City, CA

07263
Fairchild Semiconductor
North American Sales
Ridgeview, CT

07344
Bircher Co. Inc., The
Rochester, NY

07374
Optron Corp
Woodbridge, CT

07557
Campion Co. Inc.
Philadelphia, PA

07597
Bumdy Corp.
Tape/Cable Div.
Rochester, NY

07716
TRW Inc. (Can use 11502)
IRC Fixed Resistors/
Burlington
Burlington, VT

07792
Lerma Engineering Corp.
Northampton, MA

07810
Bock Corp.
Madison, WI

07910
Teledyne Semiconductor
Mtn. View, CA

07933
Raytheon Co.
Semiconductor Div.
Mountain View, CA

08FG6
Calmos Systems Inc.
Kanata, Ont. Canada

080A9
Dallas Semiconductor
Dallas, TX

08111
MF Electronics
New Rochelle, NY

08235
Industro Transistor Corp.
Long Island City, NY

08261
Spectra-Strip
An Eltra Co.
Garden Grove, CA

08445
Electri-Cord Mfg., Inc
Westfield, PA

08530
Reliance Mica Corp.
Brooklyn, NY

08718
ITT Cannon Electric
Phoenix Div.
Phoenix, AZ

08806
General Electric Co.
Minature Lamp Products
Cleveland, OH

08863
Nylomatic
Fallsington, PA

08988
Skottie Electronics Inc.
Archbald, PA

09021
Airco Inc.
Airco Electronics
Bradford, PA

09023
Cornell-Dublier Electronics
Fuquay-Varina, NC

09214
General Electric Co.
Semiconductor Products Dept.
Aubum, NY

09353
C and K Components Inc.
Newton, MA

09423
Scientific Components Inc.
Santa Barbara, CA

09922
Bumdy Corp.
Norwalk, CT

09969
Dale Electronics Inc.
Yankton, SD

09975
Burroughs Corp.
Electronics Components
Detroit, MI

1A791
LFE Electronics
Danvers, MA

1B715
(United Shoe & Nylock Corp)
-Nylock Fastener Corp.-
Paramus, NJ

10059
Barker Engineering Corp.
Kenilworth, NJ

10389
IL Tool Works Inc.
Licon Div.
Chicago, IL

11236
CTS Corp.
Resistor Products Div.
Berne, IN

11237
CTS Corp of CA
Electro Mechanical Div.
Paso Robles, CA

11295
ECM Motor Co.
Schaumburg, IL

11358
Columbia Broadcasting System
CBS Electronic Div.
Newburyport, MA

11403
Vacuum Can Co.
Best Coffee Maker Div.
Chicago, IL

11502 (can also use 35009)
TRW Inc.
TRW Resistive Products Div.
Boone, NC

11503
Keystone Columbia Inc.
Freemont, IN

11532
Teledyne Relays Teledyne
Industries Inc.
Hawthorne, CA

11711
General Instrument Corp.
Rectifier Div.
Hicksville, NY

11726
Qualidyne Corp.
Santa Clara, CA

12014
Chicago Rivet & Machine Co.
Naperville, IL

12020
Ovenaire
Div. of Electronic Technologies
Charlottesville, VA

12038
Simco
(Div of Ransburg Corp)
Hatfield, PA

12040
National Semiconductor Corp.
Danbury, CT

12060
Diodes Inc.
Northridge, CA

12136
PHC Industries Inc.
Formerly Philadelphia Handle Co.
Camden, NJ

12300
AMF Canada Ltd.
Potter-Brumfield
Guelph, Ontario, Canada

12323
Practical Automation Inc.
Shelton, CT

12327
Freeway Corp.
Cleveland, OH

12406
Elpac Electronics Inc.
Santa Ana, CA

12443
Budd Co.,The
Plastics Products Div.
Phoenixville, PA

12581
Hitachi Metals International Ltd.
Hitachi Magna-Lock Div.
Big Rapids, MO

12615
US Terminals Inc.
Cincinnati, OH

12617
Hamlin Inc.
LaKe Mills, WI

12673
Wesco Electrical
Greenfield, MA

12697
Clarostat Mfg. Co. Inc.
Dover, NH

12749
James Electronic Inc.
Chicago, IL

12856
MicroMetals Inc.
Anaheim, CA

12881
Metex Corp.
Edison, NJ

12895
Cleveland Electric Motor Co.
Cleveland, OH

12954
Microsemi Corp.
Components Group
Scottsdale, AZ

12969
Unitrode Corp.
Lexington, MA

13050
Potter Co.
Wesson, MS

13103
Thermalloy Co., Inc.
Dallas, TX

13327
Solitron Devices Inc.
Tappan, NY

13511
Bunker-Ramo Corp.
Amphenol Cadre Div.
Los Gatos, CA

13606
Sprague Electric Co.
(Use 56289)

13689
SPS Technologies Inc.
Hatfield, NJ

13764
Micro Plastics
Flippin, AZ

13919
Burr-Brown Research Corp.
Tucson, AZ

14099
Semtech Corp.
Newbury Park, CA

14140
McGray-Edison Co.
Commercial Development Div.
Manchester, NH

14189
Ortronics, Inc.
Orlando, FL

14193
Cal-R-Inc.
Santa Monica, CA

14301
Anderson Electronics
Hollidaysburg, PA

14329
Wells Electronics Inc.
South Bend, IN

14482
Watkins-Johnson Co.
Palo Alto, CA

14552
Microsemi Corp.
(Formerly Micro-Semiconductor)
Santa Ana, CA

14604
Elmwood Sensors, Inc
Pawtucket, RI

14655
Comell-Dublier Electronics
Div. of Federal Pacific
Electric Co. Govt Cont Dept.
Newark, NJ

14704
Crydom Controls
(Division of Int Rectifier)
El Segundo, CA

14752
Electro Cube Inc.
San Gabriel, CA

14936
General Instrument Corp.
Discrete Semi Conductor Div.
Hicksville, NY

14949
Trompeter Electronics
Chatsworth, CA

15412
Amtron
Midlothian, IL

15542
Scientific Components Corp.
Mini-Circuits Laboratory Div.
Brooklyn, NY

15636
Elec-Trol Inc.
Saugus, CA

15782
Bausch & Lomb Inc.
Graphics & Control Div.
Austin, TX

15801
Fenwal Eletronics Inc.
Div. of Kidde Inc.
Framingham, MA

15818
Teledyne Inc. Co.
Teledyne Semiconductor Div.
Mountain View, CA

15849
Useco Inc.
(Now 88245)

15898
International Business
Machines Corp.
Essex Junction, VT

16068
International Diode Div.
Harrison, NJ

16162
MMI
Southfield, MI

16245
Conap Inc.
Olean, NY

16258
Space-Lok Inc.
Burbank, CA

16352
Codi Corp.
Linden, NJ

16469
MCL Inc.
LaGrange, IL

16473
Cambridge Scientific Industries
Div. of Chemed Corp.
Cambridge, MD

16733
Cablewave Systems Inc.
North Haven, CT

16742
Paramount Plastics
Fabricators Inc.
Downey, CA

16758
General Motors Corp.
Delco Electronics Div.
Kokomo, IN

17069
Circuit Structures Lab
Burbank, CA

17117
Electronic Molding Corp.
Woonsocket, RI

17338
High Pressure Eng. Co. Inc.
OK City, OK

17504
Aluminum Filter Co.
Carpinteria, CA

17545
Atlantic Semiconductors Inc.
Asbury Park, NJ

17745
Angstrohm Precision, Inc.
Hagerstown, MD

17856
Siliconix Inc.
Santa Clara, CA

18178
E G & Gvactee Inc.
St. Louis, MO

18235
KRL/Bantry Components Inc.
Manchester, NH

18310
Concord Electronics
New York, NY

18324
Signetics Corp.
Sacramento, CA

18377
Parlex Corp.
Methuen, MA

18520
Sharp Electronics Corp.
Paramus, NJ

18542
Wabash Inc.
Wabash Relay & Electronics Div.
Wabash, IN

18565
Chomerics Inc.
Woburn, MA

18612
Vishay Intertechnology Inc.
Vishay Resistor Products Group
Malvern, PA

18632
Norton-Chemplast
Santa Monica, CA

18677
Scanbe Mfg. Co.
Div. of Zero Corp.
El Monte, CA

18736
Voltronics Corp.
East Hanover, NJ

18786
Micro-Power
Long Island City, NY

18927
GTE Products Corp.
Precision Material Products
Business Parts Div.
Titusville,PA

19080
Robinson Electronics Inc.
San Luis Obispo, CA

19112
Garry Corp.
Langhorne, PA

19315
Bendix Corp., The
Navigation & Control Group
Terboro, NJ

19451
Perine Machine Tool Corp.
Kent, WA

19482
Delta Electronics
Alexandria, VA

19613
MN Mining & Mfg. Co.
Textool Products Dept.
Electronic Product Div.
Irving, TX

19647
Caddock Electronics Inc.
Riverside, CA

19701
Mepco/Centralab Inc.
A N. American Philips Co.
Mineral Wells, TX

2B178
Wire Products
Cleveland, OH

2K262
Boyd Corporation
Portland, OR

2Y384
North American Philips Lighting Corp.
Van Wert, OH

20584
Enochs Mfg. Inc.
INpolis, IN

20891
Cosar Corp.
Dallas, TX

21317
Electronics Applications Co.
El Monte, CA

21604
Buckeye Stamping Co.
Columbus, OH

21845
Solitron Devices Inc.
Semiconductor Group
Rivera Beach, FL

21847
Aertech
Now TRW Microwave Inc.
Sunnyvale, CA

21962
Vectron Corp.
Replaced by: S.W. Electronics

22526
DuPont, EI DeNemours & Co. Inc.
DuPont Connector Systems
Advanced Products Div.
New Cumberland, PA

22626
Micro Semiconductor
(Now 14552)

22670
GM Nameplate
Seattle, WA

22767
ITT Semiconductors
Palo Alto, CA

22784
Palmer Inc.
Cleveland, OH

23050
Product Comp. Corp.
Mount Vernon, NY

23223
CTS Microelectronics
Lafayette, NY

23237
I.R.C., Inc.
Microcircuits Divison
Philadelphia, PA

23302
S.W. Electronics & Mfg. Corp.
Cherry Hill, NJ

23730
Mark Eyelet and Stamping Inc.
Wolcott, CT

23732
Tracor Applied Sciences Inc.
Rockville, MD

23880
Stanford Applied Engineering
Santa Clara, CA

23936
William J. Purdy Co.
Pamotor Div.
Burlingame, CA

24347
Penn Engineering Co.
S. El Monte, CA

24355
Analog Devices Inc.
Norwood, MA

24444
General Semiconductor
Industries, Inc.
Tempe, AZ

24546
Bradford Electronics
Bradford, PA

24618
Transcon Mfg.
Now: D.J. Associates Inc.

24655
Genrad Inc.
(Replaced General Radio 05173)
Concord, MA

24759
Lenox-Fugle Electronics Inc.
South Plainfield, NJ

24796
AMF Inc.
Potter & Brumfield Div.
San Juan Capistrano, CA

24931
Specialty Connector Co.
Greenwood, IN

24995
ECS
Grants Pass, OR

25088
Siemen Corp.
Isilen, NJ

25099
Cascade Gasket
Kent, WA

25403
Amperex Electronic Corp.
Semiconductor & Micro-Circuit Div.
Slatersville, RI

25435
Moldtronics, Inc
Downers Grove, IL

25706
Daburn Electronic & Cable Corp.
Norwood, NJ

26402
Lumex,Inc.
Bayshore, NY

26629
Frequency Sources Inc.
Sources Div.
Chelmsford, MA

26806
American Zettler Inc.
Irvine, CA

27014
National Semiconductor Corp.
Santa Clara, CA

27167
Corning Glass Works Corning
Electronics
Wilmington, NC

27264
Molex Inc.
Lisle, IL

27440
Industrial Screw Products
Los Angeles, CA

27494
Staffall, Inc.
Providence, RI

27745
Associated Spring Barnes Group Inc.
Syracuse, NY

27918
Component Parts Corp.
Bellmore, NY

27956
Relcom (Now 14482)

28175
Alpha Metals
Chicago, IL

28198
Positronic Industries
Springfield, MO

28213
MN Mining & Mfg. Co.
Consumer Products Div.
3M Center
Saint Paul, MN

28309
Kaiser
Minette,AL.

28425
Serv-O-Link
Euless, TX

28478
Deltrol Corporation
Deltrol Controls Div.
Milwaukee, WI

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto, CA

28484
Emerson Electric Co.
Gearmaster Div.
McHenry, IL

28520
Heyco Molded Products
Kenilworth, NJ

28932
Lumax Industrials, Inc
Altoona, PA

29083
Monsanto Co.
Santa Clara, CA

29604
Stackpole Components Co.
Raleith, NC

29907
Omega Engineering Inc.
Stamford, CT

3D536
Aimsco Inc.
Seattle, WA

30035
Jolo Industries Inc.
Garden Grove, CA

30045
Solid Power Corp.
Farmingdale, NY

30146
Symbex Corp.
Painesville, OH

30148
AB Enterprise Inc.
Ahoskie, NC

30161
Aavid Engineering Inc.
Laconia, NH

30315
Itron Corp.
San Diego, CA

30323
IL Tool Works Inc.
Chicago, IL

30800
General Instrument Corp.
Capacitor Div.
Hicksville, NY

30838
Fastec
Chicago,ILL

31019
Solid State Scientific Inc.
Willow Grove, PA

31091
Alpha Industries Inc.
Microelectronics Div.
Hatfield, PA

31323
Metro Supply Company
Sacramento, CA

31433
Kemet Electonics Corp.
Simpsonville, NC

31448
Army Safeguard Logistics Command
Huntsville, AL

31471
Gould Inc
Semiconductor Div
Santa Clara, CA

31522
Metal Masters Inc.
Baldwin, MS

31746
Cannon Electric
Woodbury, TN

31827
Budwig
Ramona, CA

31918
ITT-Schadow
Eden Prairie, MN

32293
Intersil
Cupertino, CA

32539
Mura Corp.
Westbury, Long Island, N.Y.

32559
Bivar
Santa Ana, CA

32719
Siltronics
Santa Ana, CA

32767
Griffith Plastics Corp.
Burlingame, CA

32879
Advanced Mechanical Components
Northridge, CA

32897
Murata Erie North America Inc.
Carlisle Operations
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Div.
Riverside, CA

33025
M/A ComOmni Spectra, Inc. (Replacing Omni Spectra)
Microwave Subsystems Div.
Tempe, AZ

33096
CO Crystal Corp.
Loveland, CO

33173
General Electric Co.
Owensboro, KY

33246
Epoxy Technology Inc.
Billerica, MA

33292
Pioneer Sterilized Wiping Cloth Co.
Portland, OR

33297
NEC Electronics USA Inc.
Electronic Arrays Inc. Div.
Mountain View, CA

33919
Nortek Inc.
Cranston, RI

34114
Oak Industries
Rancho Bernardo, CA

34263
CTS Electronics Corp.
Brownsville,TX

34333
Silicon General Inc.
Garden Grove, CA

34335
Advanced Micro Devices (AMD)
Sunnyvale, CA

34359
MN Mining & Mfg. Co.
Commercial Office Supply Div.
Saint Paul, MN

34371
Harris Corp.
Harris Semiconductor
Products Group
Melbourne, FL

34576
Rockwell International Corp.
Newport Beach, CA

34641
Instrument Specialties
Euless, TX

34649
Intel Corp.
Santa Clara, CA

34802
Electromotive Inc.
Kenilworth, NJ

34848
Hartwell Special Products
Placentia, CA

35009
Renfrew Electric Co. Ltd.
IRC Div.
Toronto, Ontario, Canada

35986
Amrad
Melrose Park, IL

36665
Mitel Corp.
Kanata, Ontario, Canada

36701
Van Waters & Rogers
Valley Field, Quebec, Canada

37942
Mallory Capacitor Corp.
Sub of Emhart Industries
INpolis, IN

39003
Maxim Industries
Middleboro, MA

4F434
Plastic Sales
Los Angeles, CA

40402
Roderstein Electronics Inc.
Statesville, NC

42498
National Radio
Melrose, MA

43543
Nytronics Inc.(Now 53342)

43744
Panasonic Industrial Co.
San Antonio, TX

43791
Datron Systems
Wilkes Barre, PA

44655
Ohmite Mfg. Co.
Skokie, IL

47001
Lumberg Inc.
Richmond, VA

47379
ISOCOM
Campbell, CA

49569
IDT (International Development & Trade)
Dallas, TX

49671
RCA Corp.
New York, NY

49956
Raytheon Company
Executive Offices
Lexington, MA

5D590
Mostek Corp.
Replaced by: SGS Thompson Microelectronics

5F520
Panel Components Corp.
Santa Rosa, CA

5P575
Nobel Electronics
Suffern, NY

5W664
NDK
Div. of Nihon Dempa Kogyo LTD
Lynchburg, VA

5U802
Dennison Mfg. Co.
Framingham, MA

50088
SGS - Thomson Microelectronics Inc.
Carrollton, TX

50120
Eagle-Picher Industries Inc.
Electronics Div.
CO Springs, CO

50157
Midwest Components Inc.
Muskegon, MS

50356
Teac Corp. of America
Industrial Products Div
Montebello, CA

50364
MMI, Inc.(Monolithic Memories Inc)
Military Products Div.
Santa Clara, CA

50472
Metal Masters, Inc.
City of Industry, CA

50541
Hypertronics Corp.
Hudson, MA

50558
Electronic Concepts, Inc.
Eatontown, NJ

50579
Litronix Inc.
Cupertino, CA

50891
Semiconductor Technology
Stuart, FL

50934
Tran-Tec Corp
Columbus, NE

51167
Aries Electronics Inc.
Frenchtown, NJ

51284
Mos Technology
Norristown, PA

51249
Heyman Mfg. Co.
Cleveland, OH

51372
Verbatim Corp.
Sunnyvale, CA

51398
MUPAC Corp.
Brockton, MA

51406
Murata Erie, No. America Inc.
(Also see 72982)
Marietta, GA

51499
Amtron Corp.
Boston, MA

51506
Accurate Screw Machine Co.
(ASMCO) Nutley, NJ

51605
CODI Semiconductor Inc.
Kenilworth, NJ

51642
Centre Engineering Inc.
State College, PA

51705
ICO/Rally
Palo alto, CA

51791
Statek Corp.
Orange, CA

51984
NEC America Inc.
Falls Church, VA

52063
Exar Integrated Systems
Sunnyvale, CA

52072
Circuit Assembly Corp.
Irvine, CA

52152
MN Mining & Mfg.
Saint Paul, MN

52333
API Electronics
Haugpauge,Long Island,NY

52361
Communication Systems
Piscataway, NJ

52500
Amphenol, RF Operations
Burlington, MA

52525
Space-Lok Inc.
Lerco Div.
Burbank, CA

52531
Hitachi Magnetics
Edmore, MO

52745
Timco
Los Angeles, CA

52763
Stettner-Electronics Inc.
Chattanooga, TN

52769
Sprague-Goodman Electronics Inc.
Garden City Park, NY

52771
Moniterm Corp.
Amatrom Div.
Santa Clara, CA

52840
Western Digital Corp.
Costa Mesa, CA

53021
Sangamo Weston Inc.
(See 06141)

53036
Textool Co.
Houston, TX

53184
Xciton Corp.
Lathan, NY

53217
Technical Wire Products Inc.
Santa Barbara, CA

53342
Opt Industries Inc.
Phillipsburg, NJ

53673
Thompson CSF Components Corp.
(Semiconductor Div)
Conaga Park, CA

53718
Airmold/W. R. Grese & Co.
Roanoke Rapids, NC

53848
Standard Microsystems
Hauppauge, NY

53894
AHAM Inc.
RanchoCA, CA

53944
Glow-Lite
Pauls Valley, OK

54178
Plasmetex Industries Inc.
San Marcos, CA

54294
Shallcross Inc.
Smithfield, NC

54453
Sullins Electronic Corp.
San Marcos, CA

54473
Matsushita Electric Corp.
(Panasonic)
Secaucus, NJ

54492
Cinch Clamp Co., Inc.
Santa Rosa, CA

54583
TDK
Garden City, NY

54590
RCA Corp
Distribution & Special Products
Cherry Hill, NY

54869
Piher International Corp.
Arlington Heights, IL

54937
DeYoung Mfg.
Bellevue, WA

54590
RCA Corp.
Electronic Components Div.
Cherry Hill, NJ

55026
American Gage & Machine Co.
Simpson Electric Co. Div.
Elgin, IL

55112
Plessey Capacitors Inc.
(Now 60935)

55261
LSI Computer Systems Inc.
Melville, NY

55285
Bercquist Co.
Minneapolis, MN

55322
Samtech Inc.
New Albany, IN

55408
STI-CO Industries Co
Buffalo, NY

55464
Central Semiconductor Corp.
Hauppauge, NY

55557
Microwave Diode Corp.
W.Stewarstown, NH

55566
R A F Electronic Hardware Inc.
Seymour, CT

55576
Synertek
Santa Clara, CA

55680
Nichicon/America/Corp.
Schaumburg, IL

55943
D J Associates, Inc
(Replaced Transcon Mfg.-24618)
Fort Smith, AZ

56282
Utek Systems Inc.
Olathe, KS

56289
Sprague Electric Co.
North Adams, MA

56365
Square D Co.
Corporate Offices
Palatine, IL

56375
WESCORP
Div. Dal Industries Inc
Mountain View, CA

56481
Shugart Associates
Sub of Xerox Corp.
Sunnyvale, CA

56637
RCD Components Inc.
Manchester, NH

56708
Zilog Inc.
Campbell, CA

56856
Varnistor Corp. of TN
Sevierville, TN

56880
Magnetics Inc.
Baltimore, MD

57026
Endicott Coil Co. Inc.
Binghamton, NY

57053
Gates Energy Products
Denver, CO

57170
Cambridge Thermionic
Cambridge, MA
Replaced by:
71279
Interconnection Products Inc.

57668
R-ohm Corp
Irvine, CA

57962
SGS - Thomson Microelectronics Inc
Montgomeryville, PA

58014
Hitachi Magnalock Corp.
(Now 12581)

58104
Simco
Atlanta, GA

58364
BYCAP Inc.
Chicago, IL

58451
Precision Lamp
Cotat, CA

58474
Superior Electric Co.
Bristol, CT

58614
Communications Instruments Inc.
Fairview, NC

59124
KOA-Speer Electronics Inc.
Bradford, PA

59422
Holmberg Electronics
Irvine, CA

59610
Souriau Inc
Valencia, CA

59635
HV Component Associates
Howell, NJ

59640
Supertex Inc.
Sunnyvale, CA

59660
Tusonix Inc.
Tucson, AZ

59730
Thomas and Betts Corp.
IA City, IA

59831
Semtronics Corp.
Watchung, NJ

6I1053:
American Components Inc.
an Insilco Co. RPC Div.
Hayesville, NC

6L611
Allen, Robert G. Inc.
Van Nuys, CA

6U850
Burgess Switch Co., Inc
Northbrook, IL

6U095
AMD Enterprises, Inc.
Roswell, GA

6X403
SGS/ATES Semiconductor Corp.
INpolis, IN

6Y440
Micron Technology Inc.
Boise, ID

60046
Power Dynamics Inc
West Orange, NJ

60197
Precicontact Inc.
Langhorne, PA

60386
Squires Electronics Inc
Cornelius, OR

60395
Xicor Inc.
Milpitas, CA

60399
Torin Engineered Blowers
Div. of Clevepak Corp.
Torrington, CT

60496
Micrel Inc.
Sunnyvale, CA

60705
Cera-Mite Corp.
(formerly Sprague)
Grafton, WI

60911
Inmos Corp.
CO Springs, CO

60935
Westlake Capacitor Inc.
Tantalum Div.
Greencastle, IN

60958
ACIC
Intercomp Wire & Cable Div.
Hayesville, NC

61271
Fujitsu Microelectronics Inc
San Jose, CA

61394
SEEQ Technology Inc.
San Jose, CA

61429
Fox Electronics
Cape Coral, FL

61529
Aromat Corp.
New Providence, NJ

61752
IR-ONICS Inc
Warwick, RI

61772
Integrated Device Technology
Santa Clara, CA

61802
Toshiba
Houston, TX

61857
SAN-O Industrial Corp.
Bohemia, Long Island, NY

61935
Schurter Inc.
Petaluma, CA

62351
Apple Rubber
Lancaster, NY

62643
United Chemicon
Rosemont, IL

62712
Seiko Instruments
Torrance, CA

62793
Lear Siegler Inc.
Energy Products Div.
Santa Ana, CA

63743
Ward Leonard Electric Co.Inc.
Mount Vernon, NY

64154
Lamb Industries
Portland, OR

64155
Linear Technology
Milpitas, CA

64537
KDI Electronics
Whippany, NJ

64782
Precision Control Mfg. Inc.
Bellevue, WA

64834
West M G Co.
San Francisco, CA

64961
Electronic Hardware LTD
North Hollywood, CA

65092
Sangamo Weston Inc.
Weston Instruments Div.
Newark, NJ

65786
Cypress Semi
San Jose, CA

65940
Rohm Corp & Whatney
Irvine, CA

65964
Evox Inc.
Bannockburn, IL

66150
Entron Inc.
Winslow Teltronics Div.
Glendale, NY

66302
VLSI Technology Inc.
San Jose, CA

66419
Exel
San Jose, CA

66450
Dyna-Tech Electronics, Inc
Walled Lake, MI

66608
Bering Industries
Freemont, CA

66891
BKC International Electronics
Lawrence, MA

66958
SGS Semiconductor Corp.
Phoenix, AZ

66967
Powerex Inc
Auburn, NY

67183
Altera
Santa Clara, CA

68919
WIMA
% Harry Levinson Co.
Seattle, WA

7F361
Richmond-Division of Dixico
% Zellerbach Paper Co.
Seattle, WA

7F844
Moore Business Forms, Inc
Seattle, WA

7G902
Textron Inc.
Camcar Div.
Rockford, IL

7J395
Universal Plastics
Welshpool, WA

7J696
AMD Plastics
East Lake, OH

7K354
Omni Spectra Inc
Los Altos, CA

7Z884
ALPS
Seattle, WA

7X634
Duracell USA
Div. of Dart & Kraft Inc.
Valdese, NC

70290
Almetal Universal Joint Co.
Cleveland, OH

70485
Atlantic India Rubber Works Inc.
Chicago, IL

70563
Amperite Company
Union City, NJ

70903
Cooper-Belden Corp.
Geneva, IL

71002
Bimbach Co. Inc.
Farmingdale, NY

71034
Bliley Electric Co.
Erie, PA

71183
Westinghouse Electric Corp.
Bryant Div.
Bridgeport, CT

71279
Interconnection Products Inc.
Formerly Midland-Ross Cambion Div.
Santa Ana, CA

71400
Bussman Manufacturing
Div. McGraw-Edison Co.
St. Louis, MO

71450
CTS Corp.
Elkhart, IN

71468
ITT Cannon Div. of ITT
Fountain Valley, CA

71482
General Instrument Corp.
Clare Div.
Chicago, IL

71590
Mepco/Centralab
A North American Philips Co.
Fort Dodge, IA

71707
Coto Corp.
Providence, RI

71744
General Instrument Corp.
Lamp Div/Worldwide
Chicago, IL

71785
TRW Inc.
Cinch Connector Div.
Elk Grove Village, IL

71984
Dow Corning Corp.
Midland, MI

72005
AMAX Specialty Metals Corp.
Newark, NJ

72136
Electro Motive Mfg. Corp.
Florence, NC

72228
AMCA International Corp.
Continental Screw Div.
New Bedford, MA

72259
Nytronics Inc.
New York, NY

72619
Amperex Electronic Corp.
Dialight Div.
Brooklyn, NY

72653
G C Electronics Co.
Div. of Hydrometals Inc.
Rockford, IL

72794
Dzus Fastner Co. Inc.
West Islip, NY

72928
Gulton Industries Inc.
Gudeman Div.
Chicago, IL

72962
Elastic Stop Nut
Div. of Harrard Industries
Union, NJ

72982
Erie Specialty Products, Inc
Formerly: Murata Erie
Erie, PA

73138
Beckman Industrial corp.
Helipot Div.
Fullerton, CA

73168
Fenwal Inc.
Ashland, MA

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrance, CA

73445
Amperex Electronic Corp.
Hicksville, NY

73559
Carlingswitch Inc.
Hartford, CT

73586
Circle F Industries
Trenton, NJ

73734
Federal Screw Products Inc.
Chicago, IL

73743
Fischer Special Mfg. Co.
Cold Spring, KY

73893
Microdot
Mt. Clemens, MS

73899
JFD Electronic Components
Div. of Murata Erie
Oceanside, NY

73905
FL Industries Inc.
San Jose, CA

73949
Guardian Electric Mfg. Co.
Chicago, IL

74199
Quam Nichols Co.
Chicago, IL

74217
Radio Switch Co.
Marlboro, NJ

74306
Piezo Crystal Co.
Div. of PPA Industries Inc.
Carlisle, PA

74445
Holo-Krome Co.
Elmwood, CT

74542
Hoyt Elect.Instr. Works Inc.
Penacook, NH

74840
IL Capacitor Inc.
Lincolnwood, IL

74970
Johnson EF Co.
Waseca, MN

75042
TRW Inc.
IRC Fixed Resistors
Philadelphia, PA

75297
Kester Solder Div.
Litton Systems, Inc
Des Plaines, IL

75376
Kurz-Kasch Inc.
Dayton, OH

75378
CTS Knights Inc.
Sandwich, IL

75382
Kulka Electric Corp.
(Now 83330)
Mount Vernon, NY

75569
Performance Semiconductor Corp.
Sunnyvale, CA

75915
Littelfuse Tracor
(Formerly: Tracor-Littelfuse)
Des Plaines, IL

76854
Oak Switch Systems Inc.
Crystal Lake, IL

77122
TRW Assemblies & Fasteners Group
Fastener Div.
Moutainside, NJ

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, IN

77542
Ray-O-Vac Corp
Madison, WI

77638
General Instrument Corp.
Rectifier Div.
Brooklyn, NY

77900
Shakeproof Lock Washer Co.
(Now 78189)

77969
Rubbercraft Corp. of CA Ltd.
Torrance, CA

78189
IL Tool Works Inc.
Shakeproof Div.
Elgin, IL

78277
Sigma Instruments Inc.
South Braintree, MA

78290
Struthers Dunn Inc.
Pitman, NJ

78553
Eaton Corp.
Engineered Fastener Div.
Cleveland, OH

78592
Stoeger Industries
South Hackensack, NJ

79497
Western Rubber Co.
Goshen, IN

79727
C - W Industries
Southampton, PA

79963
Zierick Mfg. Corp.
Mount Kisco, NY

8C798
Ken-Tronics, Inc.
Milan, IL

8D528
Baumgartens
Atlanta, GA

8F330
Eaton Corp.
Cutler Hammer Product Sales Office
Mountain View, CA

8T100
Tellabs Inc.
Naperville, IL

80009
Tektronix
Beaverton, OR

80031
Mepco/Electra Inc.
Morristown, NJ

80032
Ford Aerospace &
Communications Corp.
Western Development
Laboratories Div.
Palo Alto, CA

80145
LFE Corp.
Process Control Div.
Clinton, OH

80183
Sprague Products
(Now 56289)

80294
Bourns Instruments Inc.
Riverside, CA

80583
Hammerlund Mfg. Co. Inc.
Paramus, NJ

80640
Computer Products Inc.
Stevens-Arnold Div.
South Boston, MA

81073
Grayhill Inc.
La Grange, IL

81312
Litton Systems Inc.
Winchester Electronics Div.
Watertown, CT

81439
Therm-O-Disc Inc.
Mansfield, OH

81483
International Rectifier Corp.
Los Angeles, CA

81590
Korry Electronics Inc.
Seattle, WA

81741
Chicago Lock Co.
Chicago, IL

82227
Airpax Corp.
Cheshire Div.
Cheshire, CT

82240
Simmons Fastner Corp.
Albany, NY

82305
Palmer Electronics Corp.
South Gate, CA

82389
Switchcraft Inc.
Sub of Raytheon Co.
Chicago, IL

82415
Airpax Corp
Frederick Div.
Frederick, MD

82872
Roanwell Corp.
New York, NY

82877
Rotron Inc.
Custom Div.
Woodstock, NY

82879
IIT
Royal Electric Div.
Pawtucket, RI

83003
Varo Inc.
Garland, TX

83014
Hartwell Corp.
Placentia, CA

83055
Signalite Fuse Co.
(Now 71744)

83058
TRW Assemblies & Fasteners Group
Fasteners Div.
Cambridge, MA

83259
Parker-Hannifin Corp.
O-Seal Div.
Culver City, CA

83298
Bendix Corp.
Electric & Fluid Power Div.
Eatonville, NJ

83315
Hubbell Corp.
Mundelein, IL

83330
Kulka Smith Inc.
A North American Philips Co.
Manasquan, NJ

83478
Rubbercraft Corp. of America
West Haven, CT

83553
Associated Spring Barnes Group
Gardena, CA

83740
Union Carbide Corp.
Battery Products Div.
Danbury, CT

84171
Arco Electronics
Commack, NY

84411
American Shizuki
TRW Capacitors Div.
Ogallala, NE

84613
FIC Corp.
Rockville, MD

84682
Essex Group Inc.
Peabody, MA

84830
Lee Spring Co. Inc
Brooklyn, NY

85367
Bearing Distributing Co.
San Fransisco, CA

85372
Bearing Sales Co.
Los Angeles, CA

85480
W. H. Brady Co.
Industrial Product
Milwaukee, WI

85840
Brady WH Co
Industrial Products Div
Milwaukee, WI

85932
Electro Film Inc.
Valencia, CA

86577
Precision Metal Products Co.
Peabody, MA

86684
Radio Corp. of America
(Now 54590)

86928
Seastrom Mfg. Co. Inc.
Glendale, CA

87034
Illuminated Products Inc.
(Now 76854)

87516
Standard Crystal
KS City, KS

88044
Aeronautical Standards Group
Dept. of Navy & Air Force

88219
GNB Inc.
Industrial Battery Div.
Langhorne, PA

88245
Winchester Electronics
Litton Systems-Useco Div.
Van Nuys, CA

88486
Triangle PWC Inc.
Jewitt City, CT

88690
Essex Group Inc.
Wire Assembly Div.
Dearborn, MI

88786
Atlantic India Rubber Co.
Goshen, IN

88978
Philips (Now Fluke)
Mahwah, NJ

89020
Amerace Corp.
Buchanan Crimptool Products Div.
Union, NJ

89265
Potter-Brumfield
(See 77342)

89462
Waldes Truarc, Inc.
Long Island, NY

89536
John Fluke Mfg. Co., Inc.
Everett, WA

89597
Fredericks Co.
Huntingdon Valley, PA

89709
Bunker Ramo-Eltra Corp.
Amphenol Div.
Broadview, IL

89730
General Electric
Lamp Div.
Newark, NJ

9R216
Data Composition Svc, Inc
Laurel, MD

9S171
Port Plastics
Tukwila, WA

9W423
Amatom
El Mont, CA

90201
Mallory Capacitor Co.
Sub of Emhart Industries Inc.
Indianapolis, IN

90215
Best Stamp & Mfg. Co.
KS City, MO

90303
Duracell Inc.
Technical Sales & Marketing
Bethel, CT

91094
Essex Group Inc.
Suflex/IWP Div.
Newmarket, NH

91247
IL Transformer Co.
Chicago, IL

91293
Johanson Mfg. Co.
Boonton, NJ

91462
Alpha Industries Inc.
Logansport, IN

91502
Associated Machine
Santa Clara, CA

91506
Augat Alcoswitch
N. Andover, MA

91507
Froeliger Machine Tool Co.
Stockton, CA

91637
Dale Electronics Inc.
Columbus, NE

91662
Elco Corp.
A Gulf Western Mfg. Co.
Connector Div.
Huntingdon, PA

91737
ITT Cannon/Gremar
(Now 08718)

91802
Industrial Devices Inc.
Edgewater, NJ

91833
Keystone Electronics Corp.
NY, NY

91836
King's Electronics Co. Inc.
Tuckahoe, NY

91929
Honeywell Inc.
Micro Switch Div.
Freeport, IL

91934
Miller Electric Co.
Woonsocket, RI

91967
National Tel-Tronics
Div. of electro Audio Dynamics Inc
Meadville, PA

91984
Maida Development Co.
Hampton, VA

91985
Norwalk Valve Co.
S. Norwalk, CT

92218
Wakefield Corp., The
Wakefield, ME

92527
VTC Inc.
Bloomington, MN

92607
Tensolite Co.
Div. of Carlisle Corp.
Buchanan, NY

92914
Alpha Wire Corp.
Elizabeth, NJ

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, MA

94144
Raytheon Co.
Microwave & Power Tube Div.
Quincy, MA

94222
Southco Inc.
Concordville, PA

94988
Wagner Electric Corp.
Sub of Mcgraw-Edison Co.
Whippany, NJ

95146
Alco Electronic Products Inc.
Switch Div.
North Andover, MA

95263
Leecraft Mfg. Co.
Long Island City, NY

95275
Vitramon Inc.
Bridgeport, CT

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, OH

95348
Gordo's Corp.
Bloomfield, NJ

95354
Methode Mfg. Corp.
Rolling Meadows, IL

95573
Campion Laboratories Inc.
Detroit, MI

95712
Bendix Corp.
Electrical Comp. Div.
Franklin, IN

95987
Weckesser Co. Inc.
(Now 85480)

96733
SFE Technologies
San Fernando, CA

96853
Gulton Industries Inc.
Measurement & Controls Div.
Manchester, NH

96881
Thomson Industries Inc.
Port WA, NY

97464
Industrial Retainer Ring
Irvington, NJ

97525
EECO Inc.
Santa Ana, CA

97540
Whitehall Electronics Corp.
Master Mobile Mounts Div.
Fort Meyers, FL

97913
Industrial Electronic
Hardware Corp.
NY, NY

97945
Pennwalt Corp.
SS White Industrial Products
Piscataway, NJ

97966
CBS
Electronic Div.
Danvers, MA

98094
Machlett Laboratories Inc.
Santa Barbara. CA

98159
Rubber-Teck Inc.
Gardena, CA

98278
Malco A Microdot Co.
South Pasadena, CA

98291
Sealectro Corp.
BICC Electronics
Trumbill, CT

98372
Royal Industries Inc.
(Now 62793)

98388
Lear Siegler Inc.
Accurate Products Div.
San Deigo, CA

98978
IERC
(International Electronic Research Corp.)
Burbank, CA

99120
Plastic Capacitors Inc.
Chicago, IL

99217
Bell Industries Inc.
Elect. Distributor Div.
Sunnyvale, CA

99378
ATLEE of DE Inc.
N. Andover, MA

99392
Mepco/Electra Inc.
Roxboro Div.
Roxboro, NC

99515
Electron Products Inc.
Div. of American Capacitors
Duarte, CA

99779
Bunker Ramo- Eltra Corp.
Barnes Div.
Lansdown, PA

99800
American Precision Industries
Delevan Div.
East Aurora, NY

99942
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A North American Philips Co.
Milwaukee, WI

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SF-02630 ESPOO
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et Comerciale,
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Tel Aviv 61430
Tel: 972 3 483211

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Casilla de Correo 1400
Libertad 2525
Montevideo
Tel: 598-2-789015

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Coasin C.A.
Calle 9 Con Calle 4, Edif. Edinurbi
Apartado de Correos Nr-70-136
Los Ruices
Caracas 1070-A
Tel: 58 2 241-0309, 241-1248

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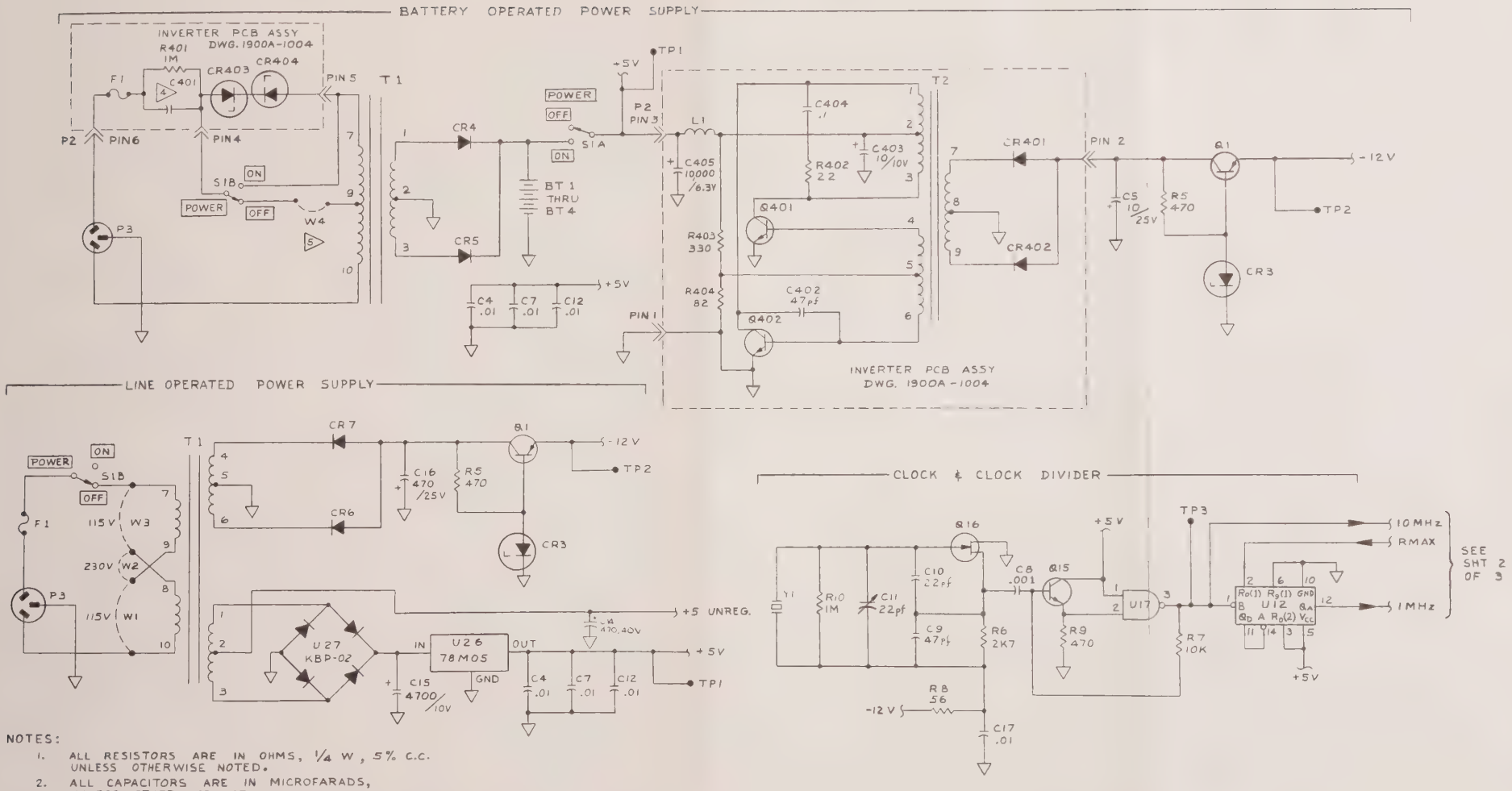
D-8045 Ismaning / Munich
Tel: 49 089 9605-260

Section 8
Schematic Diagrams

FIGURE NO.	NAME	DRAWING NO.	PAGE
8-1	Main PCB Assembly (1 of 3)	1900A–1001	8-3
8-1	Main PCB Assembly (2 of 3)	1900A–1001	8-4
8-1	Main PCB Assembly (3 of 3)	1900A–1001	8-5
8-2	Input PCB Assembly	1900A–1003	8-6
8-3	Display PCB Assembly	1900A–1002	8-7
8-4	DOU PCB Assembly	1900A–1005	8-8



NOTES:

1. ALL RESISTORS ARE IN OHMS, 1/4 W, 5% C.C. UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE IN MICROFARADS, UNLESS OTHERWISE NOTED.
3. ALL SWITCHES ARE IN RELEASE POSITION.

4. 5mf/115VAC FOR 115V/60 Hz ; 2.8mf/230VAC FOR 230V/50Hz ; 8mf/100VAC FOR 100V/50 Hz
5. SHORT W4 FOR BATTERY CONFIGURATION
6. IN LINE CONFIGURATION, SHORT W2 FOR 230V, SHORT W1 & W3 FOR 115V.

FIGURE 8-1. (1 of 3) MAIN PCB ASSEMBLY (1900A–1001)

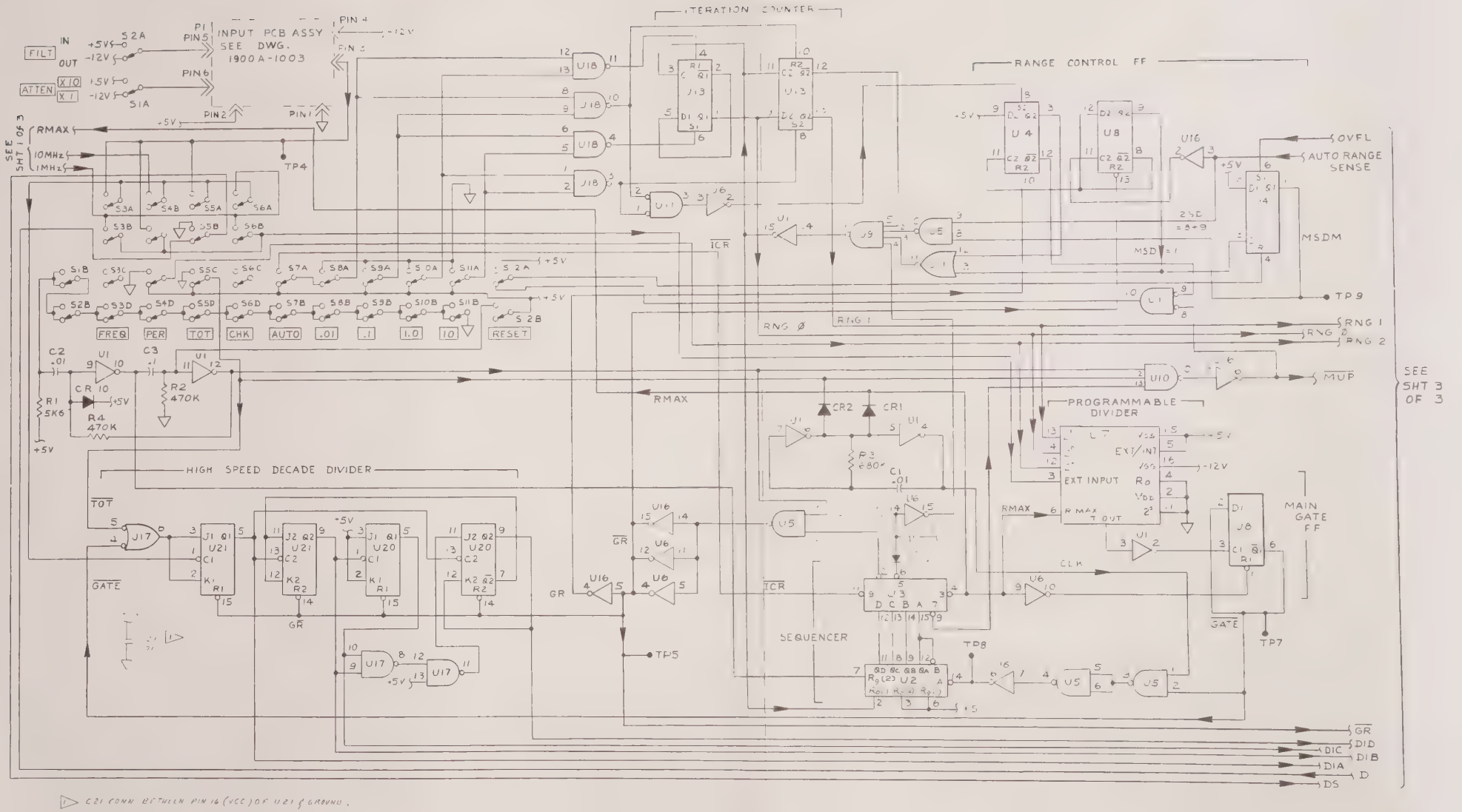
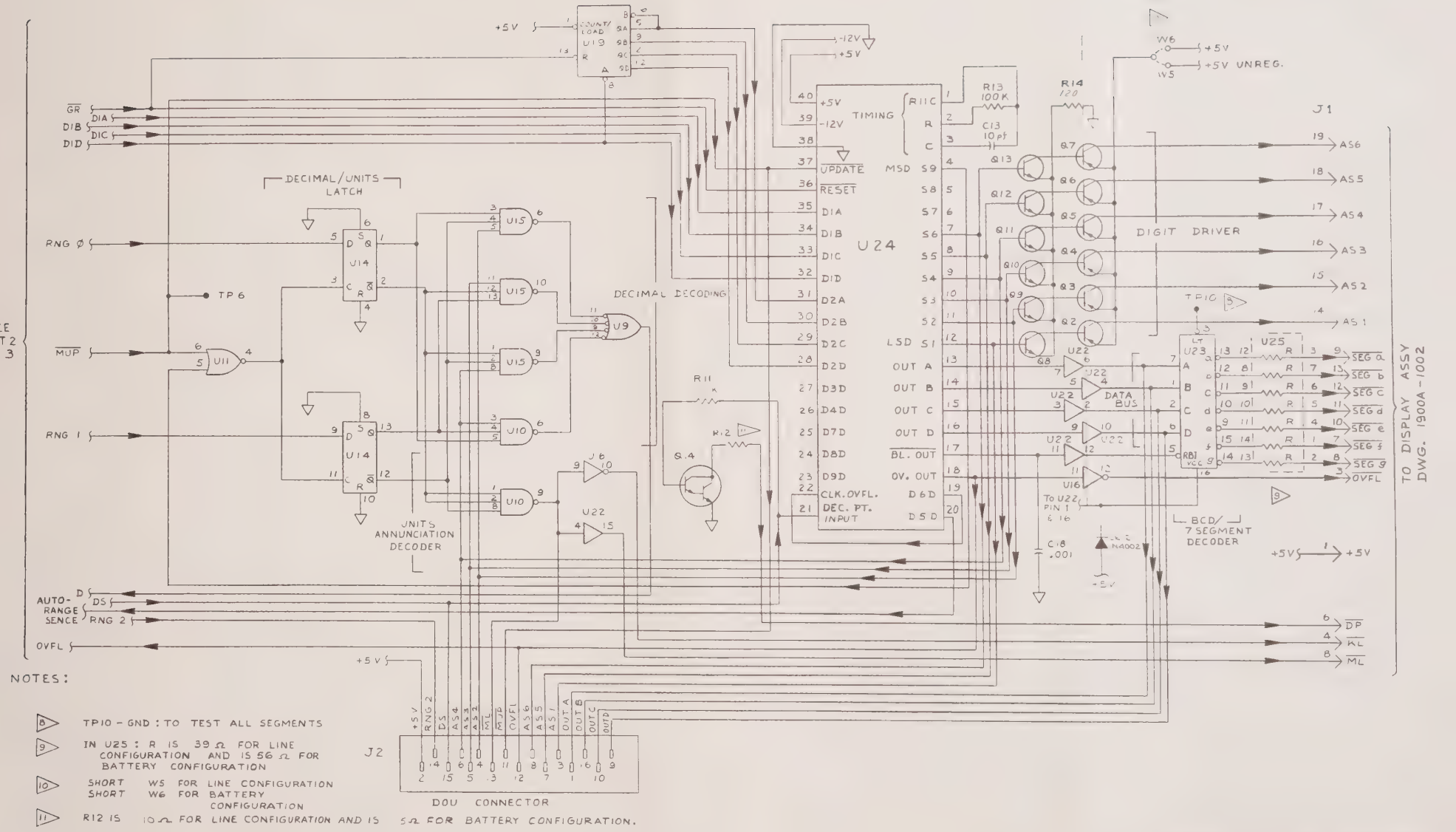


FIGURE 8-1. (2 of 3) MAIN PCB ASSEMBLY (1900A–1001)



NOTES:

8. TP10 – GND : TO TEST ALL SEGMENTS
9. IN U25 : R IS 39 Ω FOR LINE CONFIGURATION AND IS 56 Ω FOR BATTERY CONFIGURATION
10. SHORT W5 FOR LINE CONFIGURATION
    SHORT W6 FOR BATTERY CONFIGURATION
11. R12 IS 10 Ω FOR LINE CONFIGURATION AND IS 5Ω FOR BATTERY CONFIGURATION.

FIGURE 8-1. (3 of 3) MAIN PCB ASSEMBLY (1900A–1001)

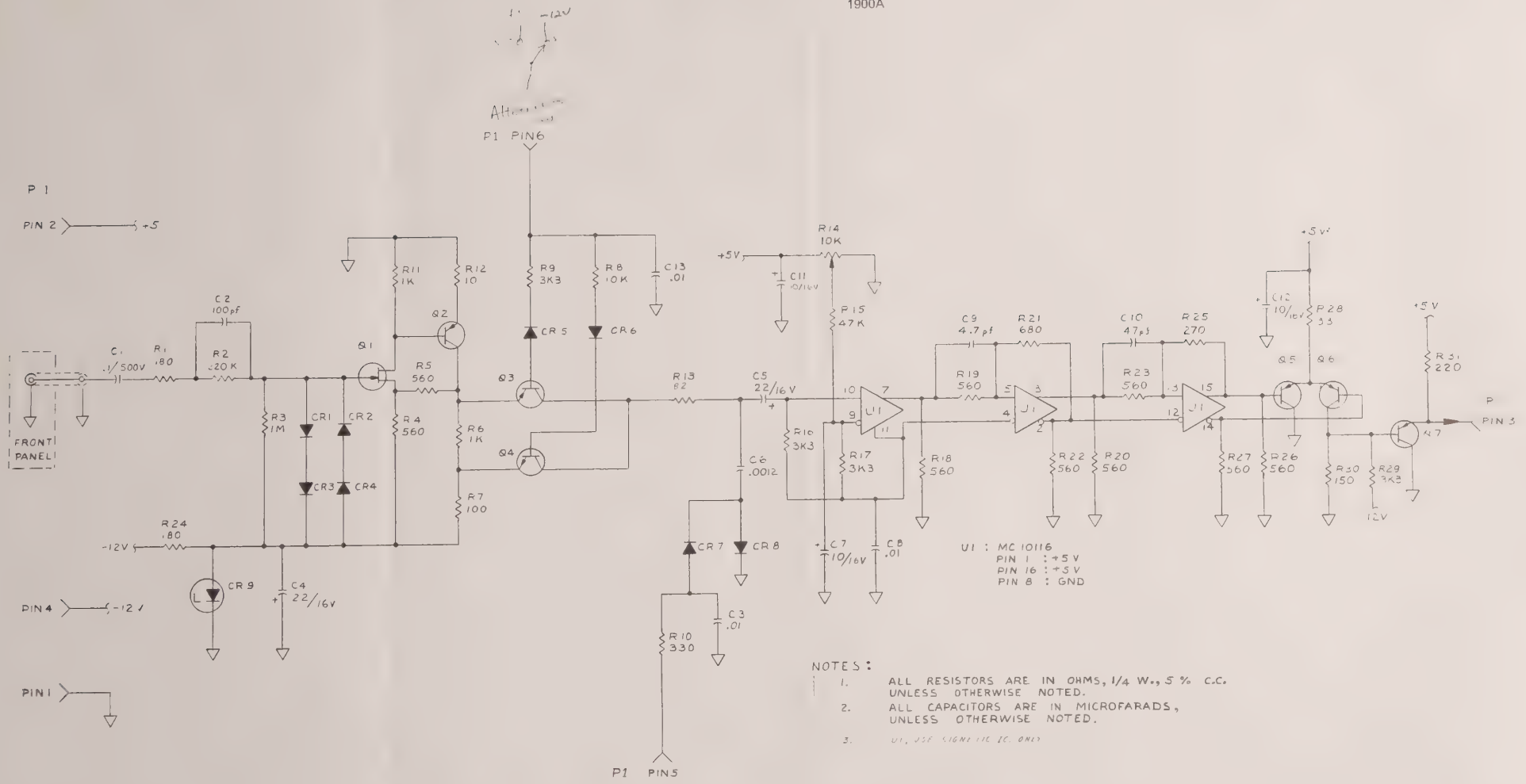
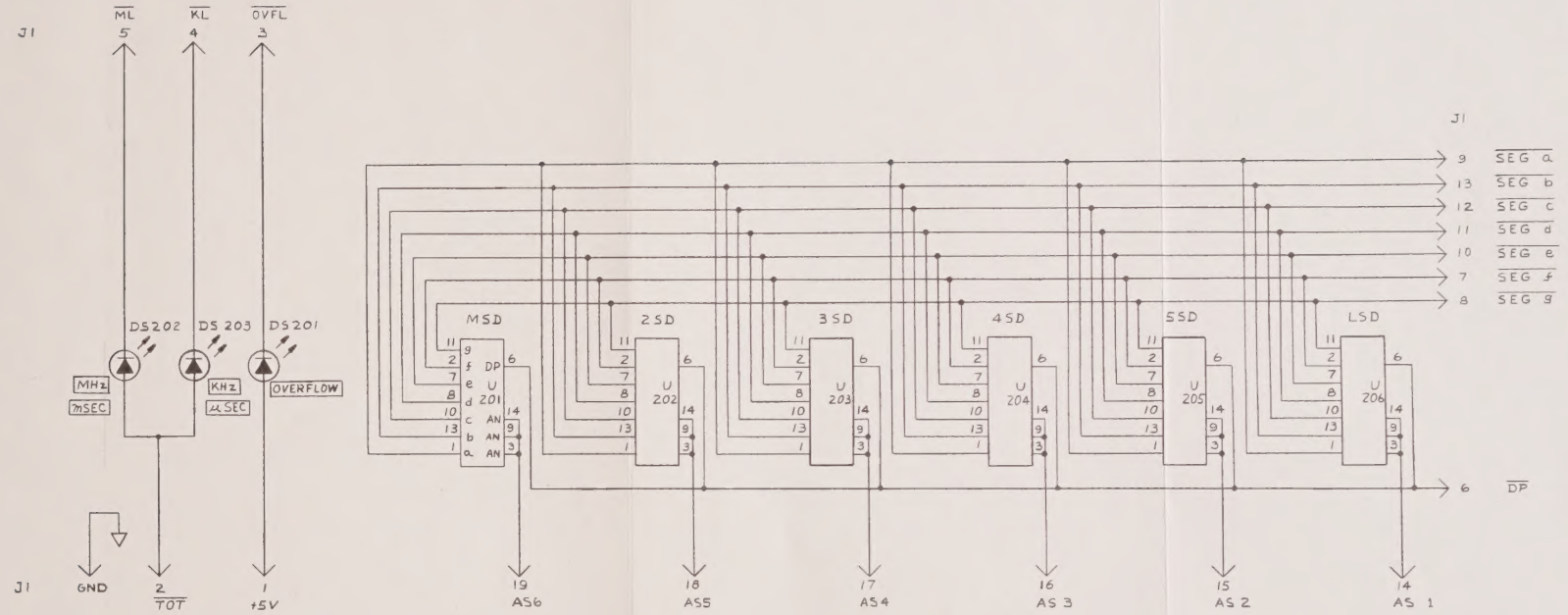


FIGURE 8-2. INPUT PCB ASSEMBLY (1900A–1003)



NOTE :

1. U201 THRU U206 CONTAIN A SEVEN SEGMENT LED DISPLAY

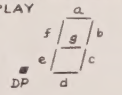
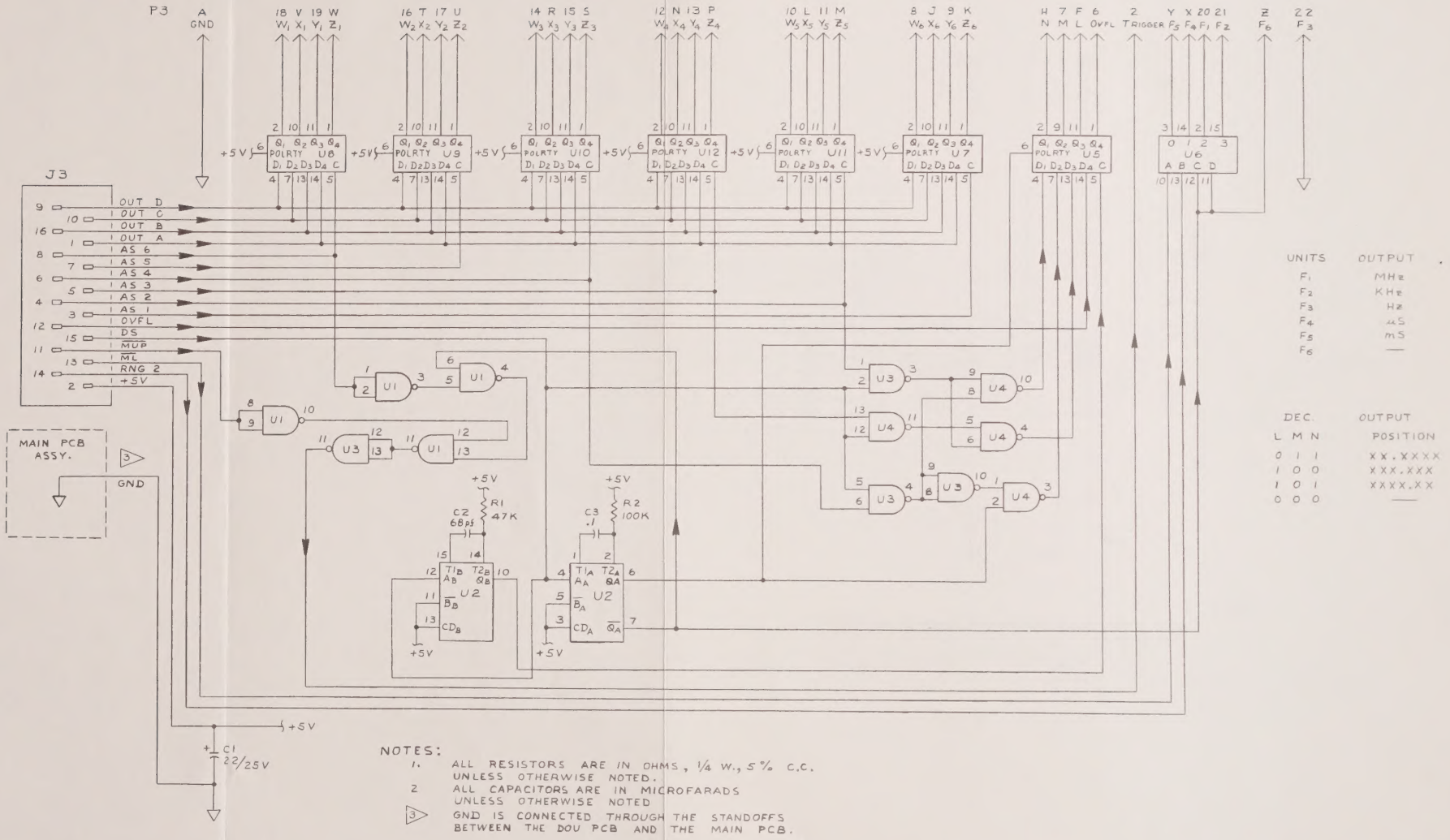


FIGURE 8-3. DISPLAY PCB ASSEMBLY (1900A–1002)



NOTES:

1. ALL RESISTORS ARE IN OHMS, 1/4 W., 5% C.C. UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE NOTED
3. GND IS CONNECTED THROUGH THE STANDOFFS BETWEEN THE DOU PCB AND THE MAIN PCB.

FIGURE 8-4. DOU PCB ASSEMBLY (1900A–1005)

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